OECD Reviews of Innovation Policy

NETHERLANDS

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Foreword

The OECD Review of the Netherland's Innovation Policy is part of a series of OECD country reviews of innovation policy.* It was requested by the Dutch authorities, represented by the Ministry of Economic Affairs and the Ministry of Education, Culture and Science and was carried out by the OECD Directorate for Science, Technology and Industry (DSTI) under the auspices of the Committee for Scientific and Technological Policy (CSTP).

The purpose of this review is to obtain a comprehensive understanding of the key elements, relationships and dynamics that drive the Dutch innovation system and the opportunities to enhance it through government policy. More specifically, the review:

- provides an independent and comparative assessment of the overall performance of the Dutch innovation system
- recommends where improvements can be made within the system
- formulates recommendations on how government policies can contribute to such improvements, drawing on the experience of other OECD countries and evidence on innovation processes, systems and policies.

The review is intended to be relevant to a wide range of stakeholders in the Netherlands, including government officials, entrepreneurs and researchers as well as the general public. It also aims to use the OECD as a communication platform to provide an accessible and comprehensive presentation of the Dutch innovation system and policy to a global audience.

A draft version of the Overall Assessment and Recommendations, containing key observations and recommendations, was presented for a peer review to the Working Party for Innovation and Technology Policy (TIP) of the CSTP in December 2013. Emerging results of the review were presented to the Committee for Industry, Innovation and Entrepreneurship (CIIE) in March 2014.

This report was drafted by Michael Keenan, Dimitrios Pontikakis, Giulia Ajmone Marsan (all Country Studies and Outlook Division [CSO], DSTI, OECD) and Peter Gal (Structural Policy Division, DSTI, OECD) with contributions from Terttu Luukkonen (consultant to the OECD; Chief Research Scientist, ETLA – The Research Institute of the Finnish Economy) and Ken Warwick (consultant to the OECD; former Chair of the CIIE) under the supervision of and with contributions from Gernot Hutschenreiter (CSO, DSTI, OECD). Georg Licht (consultant to the OECD; Head, Industrial Economics and International Management, Centre for European Economic Research, ZEW, Germany) contributed to the main fact-finding mission to the Netherlands. Hélène Dernis (Economic Analysis and Statistics Division, DSTI, OECD), Andrès Barreneche (CSO, DSTI, OECD) and Thiago Messena (working at DSTI at the time of his contribution) provided valuable input, statistical support and web-based research.

*www.oecd.org/sti/innovation/reviews

The review draws on the results of a series of interviews with major stakeholders of the Dutch innovation system, and a background report commissioned by the Dutch authorities. This background report was prepared by TNO and authored by Marcel de Heide, Walter Manshanden, Evgueni Poliakov and Jelmer Ypma. In addition, the Netherlands' Ministries of Economic Affairs and Education Culture and Science provided a staff paper. The two documents contained a broad range of information that is widely drawn upon in this report.

The review owes much to the support and co-operation of Dutch government officials, in particular Sander Kes and, in the initial phase, Arie van der Zwan (both Ministry of Economic Affairs) and Jacky Bax and Jos Rokx (both Ministry of Education, Culture and Science) as well as Francien Heijs (Ministry of Education, Culture and Science and Delegate to the CSTP) and Harry Oldersma (Economic Counsellor, Permanent Delegation of the Netherlands to the OECD), who provided information and comments, arranged the interviews during the fact-finding missions in the Netherlands and provided invaluable support throughout the review process. The report has benefited from comments and additional information received from stakeholders in the Netherlands, delegates of the CSTP and CIIE, the TIP peer review – in particular Jan Larosse (Policy Advisor to the Government of Flanders, Belgium) who acted as peer reviewer – and distinguished experts in the field.

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Abbreviations and acronyms

AAGR	Average Annual Growth Rate
AMOLF	Institute for Atomic and Molecular Physics *(Instituut voor Atoom- en Molecuulfysica)*
ASMI	Advanced Semiconductor Materials International
ASML	Advanced Semiconductor Materials Lithography
ASTRON	Netherlands Institute for Radio Astronomy *(Nederlands Instituut voor Radioastronomie)*
AWT	Advisory Council for Science and Technology Policy *(Adviesraad voor het Wetenschaps)*
BRIC	Brazil, Russian Federation, India and People's Republic of China
BERD	Business Expenditures for Research and Development
BMKB	SME Loan Guarantee Scheme *(Borgstelling MKB Kredieten)*
BRIC	Brazil, Russian Federation, India and People's Republic of China
BSIK	Investment Grants for Knowledge Infrastructure *(Besluit Subsidies Investeringen Kennisinfrastructuur)*
CBS	Fungal Biodiversity Centre *(Centraalbureau voor Schimmelcultures)*
CIS	Community Innovation Survey
CIP	Competitiveness and Innovation Framework Programme
CERN	European Council for Nuclear Research
CEZIM	Economic Affairs, Infrastructure and Environment Committee *(Commissie voor Economische Zaken, Infrastructuur en Milieu)*
CNRS	*Centre National de la Recherche Scientifique*
COST	European Cooperation in Science and Technology
CPB	The Netherlands Bureau for Economic Policy Analysis *(Centraal Planbureau)*
CWI	Centre for Mathematics and Computer Science *(Centrum Wiskunde en Informatica)*
DANS	Data Archiving and Networked Services
DIFFER	Dutch Institute for Fundamental Energy Research
DLO	Agricultural Research Service *(Dienst Landbouwkundig Onderzoek)*
DNB	Dutch National Bank *(De Nederlandsche Bank)*
DSM	Dutch State Mines
ECN	Energy Centre of the Netherlands *(Energieonderzoek Centrum Nederland)*

EIT	European Institute of Innovation and Technology
EMBC	European Molecular Biology Conference
EMBL	European Molecular Biology Laboratory
EPL	Employment Protection Legislation
EPO	European Patent Office
ERA	European Research Area
ERC	European Research Council
ERDF	European Regional Development Fund
ESFRI	European Strategy Forum on Research Infrastructures
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructure
EPO	European Patent Office
ESA	European Space Agency
ESO	European Organisation for Astronomy Research
EU	European Union
EUR	Euros
EUREKA	Raising the Competitiveness of European Business through Technology
EZ	Ministry of Economic Affairs *(Ministerie van Economische Zaken)*
FDI	Foreign Direct Investment
FET	Future and Emerging Technologies
FES	Interdepartmental Funds for Economic Restructuring *(Fonds Economische Structuurversterking)*
FOM	Foundation for Fundamental Research on Matter *(Stichting voor Fundamenteel Onderzoek der Materie)*
FP	Framework Programme
FTE	Full Time Equivalent
G20	Group of Twenty Finance Ministers and Central Bank Governors
GDP	Gross Domestic Product
GERD	Gross Expenditures for Research and Development
GNP	Gross National Product
GBAORD	Government Budget Appropriations or Outlays on R&D
GO	Business Loan Guarantee Scheme *(Garantie Ondernemingsfinanciering)*
GOVERD	Governmental Intramural Expenditures for Research and Development
GTI	Large Technological Institute *(Grote Technologische Institute)*
GVC	Global Value Chain
HCR	Highly-cited Researchers
HEI	Higher Education Institute

HERD	Higher Education Expenditures for Research and Development
HRST	Human Resources in Science and Technology
HTSM	High-tech Systems and Materials
IBO	Interdepartmental Investigation on Innovation Policy *(Interdepartementaal Beleids Onderzoek Technologiebeleid)*
ICIN	Interuniversity Cardiology Institute of the Netherlands *(Interuniversitair Cardiologisch Instituut Nederland)*
ICT	Information and Communication Technologies
IHS	Institute for Housing and Urban Development Studies
IISG	International Institute of Social History *(Internationaal Instituut voor Sociale Geschiendenis)*
IP	Intellectual Property
IPC	Innovation Performance Contract
IPR	Intellectual Property Rights
ISIC	International Standard Industrial Classification of All Economic Activities
ISP	Internet Service Provider
ITER	International Thermonuclear Experimental Reactor
I&M	The Netherlands Ministry of Infrastructure and the Environment *(Ministerie van Infrastructuur en Milieu)*
JPO	Japan Patent Office
JTI	Joint Technology Initiative
JSTP	Joint Thematic Research Programme
KBC	Knowledge-based Capital
KIBS	Knowledge-intensive Business Services
KIC	Knowledge and Innovation Community (EIT)
KiM	The Netherlands Institute for Transport Policy Analysis *(Kennisinstituut voor Mobiliteitsbeleid)*
KIS	Knowledge-intensive Services
KITLV	Royal Netherlands Institute of Southeast Asian and Caribbean Studies *(Koninklijk Instituut voor Taal-, Land- en Volkenkunde)*
KNAW	Netherlands Academy of Arts and Sciences
KNMI	Royal Netherlands Meteorological Institute *(Koninklijk Nederlands Meteorologisch Instituut)*
KPN	Royal Dutch Post, Telegraph and Telephone *(Koninklijke Posterijen, Telegrafie en Telefonie Nederland)*
MARIN	Maritime Research Institute of the Netherlands
MENA	Middle East and North Africa
MFP	Multi-factor Productivity
MIT	SME Innovation Support Top Sectors *(MKB-innovatiestimulering Topsectoren)*

MKB	Small and Medium-sized Enterprise *(Midden- en Kleinbedrijf)*
MNE	Multinational Enterprise
MSCA	Marie Sklodowska-Curie Actions
NACE	European Classification of Economic Activities *(Nomenclature des Activités Économiques dans la Communauté Européenne)*
NEET	Not in Employment, Education or Training
NFI	The Netherlands Forensic Institute
NII	Dutch Investment Agency
NIAS	Netherlands Institute for Advanced Studies
NIDI	Netherlands Interuniversity Demographic Institute *(Nederlands Interdisciplinair Demografisch Instituut)*
NIKHEF	National Institute for Subatomic Physics *(Nationaal Instituut voor Subatomaire Fysica)*
NIN	Netherlands Institute for Neuroscience
NIOD	Netherlands Institute for War Documentation *(Nederlands Instituut voor Oorlogs-, Holocaust- en Genocidestudies)*
NIOF	Royal Netherlands Institute for Sea Research *(Noordelijke Innovatie Ondersteuningsfaciliteit)*
NIOO	Netherlands Institute of Ecology *(Nederlands Instituut voor Ecologie)*
NLR	National Aerospace Laboratory *(Nationaal Lucht- en Ruimtevaartlaboratorium)*
NSCR	Netherlands Institute for the Study of Crime and Law Enforcement *(Nederlands Studiecentrum Criminaliteit en Rechtshandhaving)*
NUFFIC	Netherlands Organisation for Co-operation in Higher Education
NWIB	The Dutch Scientific Institutes Abroad *(Nederlandse Wetenschappelijke Instituten in het Buitenland)*
NWO	Netherlands Organisation for Scientific Research *(Nederlandse Organisatie voor Wetenschappelijk Onderzoek)*
NXP	Next Experience
OCW	The Netherlands Ministry of Education, Culture and Science *(Ministerie van Onderwijs, Cultuur en Wetenschap)*
OECD	Organisation for Economic Co-operation and Development
OHIM	The Office for Harmonization in the Internal Market
PBL	The Netherlands Environmental Agency *(Planbureau voor de Leefomgeving)*
PCT	Patent Cooperation Treaty
PhD	Doctor of Philosophy
PIAAC	Programme for the International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
PMR	Product Market Regulation
PPP	Purchasing Power Parity

PPPs	Public-Private Partnerships
PQI	Patent Quality Index
PRI	Public Research Institute
RAAK	Regional Attention and Action for Knowledge Circulation
REZIM	Economic Affairs, Infrastructure and Environment Subcommittee *(Raad voor Economische Zaken, Infrastructuur en Milieu)*
RCA	Revealed Comparative Advantage
RCE	The National Service for Cultural Heritage *(Rijksdienst voor het Cultureel Erfgoed)*
RDA	Research and Development Allowance
RDM	Research, Design and Manufacturing
RKD	The Netherlands Institute for Art History *(Rijksbureau voor Kunsthistorische Documentatie)*
RG	Growth Facility Scheme *(Regeling Groeifaciliteit)*
RIS3	Research and Innovation for Smart Specialisation Strategy
ROA	Research Centre for Education and the Labour Market *(Researchcentrum voor Onderwijs en Arbeidsmarkt)*
RVO	The Netherlands Enterprise Agency *(Rijksdienst voor Ondernemend Nederland)*
R&D	Research and Development
RSV	Rijn-Schelde-Verolme Shipyard
SBIR	Small Business Innovation Research Programme
SHOK	Strategic Centres for Science, Technology and Innovation *(Strategisen Huippuosaamisen Keskittymissä)*
SER	The Social and Economic Council of the Netherlands *(Sociaal-Economische Raad)*
SRON	Netherlands Institute for Space Research *(Stichting voor Ruimteonderzoek Nederland)*
STI	Science, Technology and Innovation
STW	The Technology Foundation for Technical Sciences *(Stichting voor de Technische Wetenschappen)*
SEP	Standard Evaluation Protocol
SME	Small and Medium-sized Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
S&E	Science and Engineering
S&T	Science and Technology
TBP	Technology Balance of Payments
TFA	Technical Research Council
TFP	Total Factor Productivity
TKI	Top Consortia for Knowledge and Innovation *(Topconsortia voor Kennis en Innovatie)*

TNO	Dutch Research and Technology Organisation *(Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek)*
TO2	Applied Research Institutions *(Toegepast Onderzoek Organisaties)*
TTO	Technology Transfer Office
TTI	Major Technological Institute *(Technologische Topinstituten)*
TTR-ELAt	Top Technology Region/Eindhoven-Leuven-Aachen Triangle
UAS	Universities of Applied Sciences *(Hogescholen)*
UNU-MERIT	United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology
USD	United States Dollars
USPTO	United States Patent and Trademark Office
VSNU	Association of Dutch Universities *(Vereniging van universiteiten)*
VTT	Technical Research Centre of Finland *(Valtion Teknillinen Tutkimuskeskus)*
VWS	The Netherlands Ministry of Health, Welfare and Sport *(Ministerie van Volksgezondheid, Welzijn en Sport)*
WO	Academic Universities *(Wetenschappelijk Onderwijs)*
WODC	The Scientific Research and Documentation Centre *(Wetenschappelijk Onderzoek- en Documentatiecentrum)*
WBSO	Research and Development Promotion Act *(Aftrek voor Speur- en Ontwikkelingswerk)*
WUR	Wageningen University and Research Centre
WRR	Scientific Council for Government Policy *(Wetenschappelijke Raad voor het Regeringsbeleid)*
ZONMW	Netherlands Organisation for Health Research and Development *(Nederlandse Organisatie voor Gezondheidsonderzoek en Zorginnovatie)*

Executive summary

Boost innovation to meet economic and societal challenges

- The Netherlands has one of the most advanced economies in the world. But it is also facing some challenges. It is still overcoming a protracted recession. Ongoing demographic change requires that economic growth increasingly depends on productivity gains. Dutch exporters have benefited less than some other EU countries from the expansion into emerging markets. Innovation is a key to future growth and competitiveness, and is also needed to address societal and environmental challenges, including energy supply and climate change.

- Dutch policies in the area of innovation recognise these challenges and reflect high aspirations, aiming to place the Netherlands among the top five knowledge economies globally. In light of the high quality of its human resources and excellent universities, the Netherlands is in a good position to fulfil this ambition. Further improvements in innovation policies and performance can help.

Enhance the benefits of the top sectors approach

- The new top sectors approach based on public-private partnerships is well suited to achieve alignment of strategies and pooling of resources. It has the potential to bring about closer co-operation between business and knowledge institutes, such as universities, and to raise the scope and ambition of business innovation (including in performing more R&D).

- The impact of the top sectors could be enhanced, however, by ensuring a strong representation of smaller and entrepreneurial companies, and by extending coverage – or at least transferring valuable experience and policy lessons – to other sectors with room for improvement in the intensity, scope and ambition of their innovation activities.

- The top sector approach would also benefit from a process to identify possible new areas of strength. This would help ensure the necessary dynamism in the top sectors in light of societal challenges, emerging technologies and changes in global demand. Care should also be taken not to align a too large share of public resources for fundamental research with the top sectors. It will be important to closely monitor its impact on the strong international performance of Dutch fundamental research.

Strengthen business capabilities for world-class innovation

- Dutch enterprises are among the world's leading innovators, with strong technological capabilities and performance. However, the business sector as a whole invests less in R&D and in knowledge-based capital than is the case in other advanced innovation systems. It would be important to broaden the base for innovation and engage more firms in innovation activities, especially in sectors that, relative to other advanced systems, collaborate little with knowledge institutes and conduct little R&D.

- The current system of R&D tax credits is well-designed, but does not serve all of the varying needs of the business sector. Rebalancing the system with a sufficient focus on competitive, well-designed direct support instruments (e.g. for joint R&D projects with knowledge institutes, including instruments used in the context of the top sector approach) would be better suited to longer-term and more ambitious innovation and would also serve the needs of SMEs subject to liquidity constraints.

- Young and entrepreneurial firms account for most of net job growth in the Netherlands and are an important source of radical innovation. However, start-ups grow only little in the Netherlands as they age and many never grow beyond one employee. Improving the environment for experimentation by young firms includes further improvement in product market regulation, e.g. as regards licensing and permits; improved labour market regulation, notably rules as regards permanent contracts; and stronger financing for innovative firms.

Maintain world-class public research, particularly in universities

- The Netherlands has strong research universities as reflected in the number and quality of scientific publications, as well as high research productivity. Most Dutch universities do very well in international rankings. Policy should continue to nurture high-quality research performed in the public sector. This involves maintaining healthy funding streams for fundamental research.

- Public budgets for applied research institutes (PRIs) have remained stable over the last decade. In the coming years they are set to fall and will be increasingly tied to the Top Sectors. Universities, too, are increasingly relying on competitive funding and are moving into the types of research traditionally carried out by PRIs. While these changes in funding regime are improving links with industry, they also carry risks: universities and PRIs require core funding to maintain a healthy knowledge base and to perform their primary roles in the provision of skills and of public goods. Government will need to strike a balance and avoid cutting too much in core funding.

Improve valorisation and skills

- The Dutch government places much emphasis on the commercialisation of public research. Dutch universities have strong links with the business sector, as reflected in a comparatively high share of industry funding for university research and the high rate of co-publication. The strong focus on commercialisation is welcome, but should not detract from the other important contributions that university research makes to the economy, particularly for the development of skills that diffuse across the economy.

- The Netherlands has a strong and highly educated workforce for innovation, but has faced challenges in maintaining quality in tertiary education and responding to emerging labour market needs. The share of science and engineering graduates also remains relatively low. Existing initiatives to encourage profiling and specialisation of university teaching and research activities could enhance efficiency, though care should be taken to avoid "blank spots" in national coverage of disciplines. Co-ordination in the Human Capital Agendas of the Top Sectors and the Technology Pact could help improve responsiveness to labour market demand.

- The universities of applied sciences (UAS) perform relatively little and mostly applied research. They play an important role in the provision of innovation skills and have strong links to industry. Strengthening their research capabilities would be well-timed as they could bridge the divide between firms with little or no innovation experience and world-class research universities and PRIs. This will require greater levels of government investment in UAS research capabilities, and the strengthening of links between nascent research activities and existing teaching programmes.

Chapter 1

Overall assessment and recommendations

This chapter presents an overall assessment of the Netherlands' innovation system and policy, reflecting key findings of the review. It identifies strengths and weaknesses of the innovation system and key tasks of innovation policy, and develops specific policy recommendations.

On many accounts, the Netherlands is among Europe's most advanced economies. It is a founding member of the European Union and part of the European Economic and Monetary Union (euro zone). It is one of the most open OECD economies and ranks ninth among OECD countries in terms of GDP per capita, with a gap of 13% *vis-à-vis* the United States, which is largely accounted for by labour utilisation. The main contributing factors are low average working hours, owing in part to the prevalence of part-time work, an early effective retirement age and high numbers of disability recipients. Labour productivity, measured as GDP per hour worked, is just 2% below the level of the United States.

The Netherlands has derived much of its wealth from trade and other international transactions and is tightly integrated in the global economy through trade and foreign investment. Dutch exports have grown rapidly in recent decades as intra-EU and world trade have expanded. Openness to international trade (measured as the average of imports and exports of goods and services over GDP) is one of the highest among OECD countries and has increased over the past decade.

In the services sector, the Netherlands has traditional strengths in trade, transport and logistics – owing in part to its favourable geographical position – and acts as a gateway to continental Europe and to the United Kingdom. It is a major logistics hub. Rotterdam is Europe's main port and Schiphol is one of the largest airports in Europe and a centre of economic activity for the surrounding region. These strengths can be traced back to the country's early specialisation, which has continuously evolved with the institutional and technological changes – especially in transport and information and communication technology (ICT) – that have underpinned contemporary globalisation. Services – trade, transport and logistics, but also financial and other business services – account for nearly 40% of total Dutch value added. Dutch industry has important strengths in food processing, chemicals, petroleum refining and electrical machinery.

1.1. Achievements and challenges

In a long-term perspective, the Dutch economy has enjoyed comparatively high growth. After the Second World War the economy grew rapidly, catching up with US income levels until the mid-1970s. Economic expansion has not always been smooth, however. While its GDP per capita was well ahead of that of European comparator countries in 1970, its lead narrowed over time. A mismatch between productivity and wage increases started to appear in the 1970s, the effects of which came to be referred to as the "Dutch disease". The situation was due in part to the negative side effects of the successful development of the gas sector, as real wage appreciation led to an erosion of competitiveness in other tradable products. In response to this situation, the Wassenaar Agreement – concluded in 1982 between business and labour unions, and later endorsed by the government – included a combination of cost cutting and institutional reforms, as well as other incentives. As a result, real wages declined and increases in unit labour costs remained below the EU15 average. An increased role for the services sector and diversification of exports also helped. The Dutch economy and productivity then rebounded and grew rapidly.

The Netherlands managed once more to stay roughly on par with the United States in the 1990s (the "Dutch miracle"). The downturn at the beginning of the 2000s affected the country, however, and in 2003 the Dutch economy was in recession. This was attributed at least in part to a deterioration in the competitive position of the Dutch economy. Growth picked up again in the years preceding the 2008-09 crisis, with the Netherlands growing faster than many comparators. Following the downturn in 2009 the Netherlands did not rebound as quickly as other countries in northern and central Europe, and the economy double-dipped in 2012. The Netherlands is now gradually emerging from a protracted recession.

Productivity is a main driver of economic development in the long term. As labour market participation has a natural limit, higher labour productivity is the only source of sustained economic growth. This is especially relevant for developed countries such as the Netherlands, where demographic changes are expected to constrain labour market participation in the years to come. While Dutch productivity levels are high overall, the growth of multi-factor productivity (MFP), i.e. the joint efficiency of the production inputs, labour and capital, has been relatively low among comparator OECD countries over the past 25 years. The United States, Germany and Sweden have achieved higher MFP growth despite already high levels of productivity, while others have caught up to the international frontier during the last decades. Only Denmark and Switzerland had lower rates of MFP growth than the Netherlands among comparator countries. Slow productivity growth combined with disproportionately strong increases in labour costs raises unit labour costs. Over the two decades from 1991, unit labour costs in the Netherlands increased faster than in comparator countries. This has eroded competitiveness.

Dutch exports have grown rapidly in recent decades. The Netherlands is the second largest exporter among EU countries in gross terms, and its export market performance has been strong in international comparisons. Participation in the global economy now increasingly takes place through global value chains (GVCs), and, unlike other OECD countries, the Netherlands has increased its export market shares over the past decades. This is largely due to increased re-exports of goods – about 43% of total exports in 2012 – with little domestic value added compared to domestically produced goods. Most exports are accounted for by a small number of large firms, as in other small open economies with large domestic enterprises.

Even though international trade flows continue to expand, links with dynamic emerging markets are relatively weak. Only about 5% of gross exports go to the BRICs (Brazil, the Russian Federation, India and the People's Republic of China), whereas around 10% of Germany's or Sweden's gross exports go to these countries. In terms of domestic value added content, the Netherlands' share of exports to BRICs is higher than in terms of gross exports. This is due to indirect exports from the Netherlands to emerging economies through integration in value chains (e.g. intermediate inputs supplied to German assemblers which export to BRIC countries). However, the overall pattern is that the Netherlands' share of exports to the BRICs lags that of European peers, with the exception of the United Kingdom. This suggests that it may be difficult for trade expansion to drive future growth, as the traditional Dutch export markets are likely to continue to lose weight in overall world demand. Future success in the BRICs will depend, among other things, on the qualitative characteristics of the Dutch bundle of exports. Cross-country comparisons of indicators based on export prices (unit values) suggest that "high-quality" segments are a smaller share of manufacturing exports than in peer countries. The increase in unit labour costs has also exerted downward pressure on international competitiveness, as it has been, over the longer term, stronger than in other OECD countries.

As noted, productivity is the main driver of economic development in the long term, and the major source of differences across countries in GDP per capita. For the most developed countries, innovation tends to be the main driver behind increases in productivity, and notably in multi-factor productivity. An advanced country's long-run economic performance thus relies on the level and quality of its innovation activities, i.e. the ability to generate, transfer and assimilate technological, non-technological, managerial, organisational and institutional innovations. Innovation can make an important contribution to increasing labour productivity growth and can therefore help contain unit labour costs and strengthen the international competitiveness of Dutch businesses. Innovation can also help to improve the quality of products, allow firms to move their outputs up the quality ladder, or help them introduce radically new products and services. An upgraded export bundle can also help extend the reach of Dutch exports and enhance the benefits from globalisation.

The prosperity of countries such as the Netherlands, which are at or near the technological frontier, hinges on maintaining a continuing flow of innovation, based on knowledge and technology absorbed from abroad and, to a lesser extent, developed at home. Continuously adopting existing best practices is necessary, but to preserve a top international position, the Netherlands also has to engage in new-to-the-world innovation. It is in many ways well equipped to face the challenges ahead. It not only has a great and long-standing tradition of excellence in science and technology, its science base still excels on many counts and in many areas. But there is scope for improvement. This will require stronger investment in R&D and innovation, notably by the business sector, but also excellent framework conditions and a well-functioning innovation system that ensure high returns to these knowledge-based investments.

The OECD Innovation Strategy has argued that innovation policy can contribute significantly to strong innovation performance and to an innovative, knowledge-based economy and society. Learning from best innovation policy practices in innovating countries plays an important role in that context. At the same time, Dutch policy experience is at the cutting edge in many areas and contributes to the pool of good policy practices.

1.2. Main strengths and weaknesses of the Dutch innovation system

Table 1.1 presents the results of a SWOT analysis of the Dutch innovation system. Overall, the Netherlands is a strong performer of innovation. It needs to remain at the top or, in areas where it is currently lagging, to move towards the top in order to sustain its high standard of living and quality of life. It faces challenges but can build on its strengths and capabilities to tackle them.

Table 1.1. SWOT (strengths, weaknesses, opportunities, threats) analysis of the Dutch innovation system

Strengths	Opportunities
• Successful long-term socioeconomic performance. • Strong export performance. • A strong human resource base. • Overall good framework conditions for innovation including solid institutions and a supportive business environment. • Tight integration in the global economy. Multinationals with global reach, including in R&D and innovation. • Specialisation in services and some manufacturing industries. • Highly developed infrastructure, including transport and ICT. A first rank European logistics hub. • A strong science base with strong research universities and public research institutes and excellent output in terms of the number and quality of scientific publications, and high productivity. • Strong technological capabilities and performance of Dutch firms. • Strong participation in European Framework Programmes and other international co-operative efforts and networks. • Innovative approaches, design, and delivery of innovation policy. • Strong evaluation culture.	• Good conditions to benefit further from globalisation. • Further contributions of research institutions to social and economic development. • Creation and growth of new innovative firms. • Further development of regional knowledge hubs involving companies and the public research infrastructure with strong national and international connections. • Further internationalisation of research, including through attraction of foreign researchers and students and the attraction of foreign direct investment in R&D. • Further development of innovation in services. • Policy initiatives to address Grand Challenges, including through the use of demand-side instruments. • New approaches and practices in innovation procurement. • Comprehensive innovation strategy to strengthen core actors and long-term commitments across sectors (and levels of government). • Stronger dynamism of the top sectors to allow the growth of economic activities of increasing global importance.

Weaknesses	Threats
• Weak post-crisis macroeconomic performance and some longer-term issues around productivity growth. • Lagging productivity in some sectors. • Relatively low share of exports to BRICs. • Some aspects of the framework conditions for innovation, e.g. in the area of financing enterprises. • Low R&D expenditure and low propensity to collaborate with knowledge institutions in parts of the business sector. • Specialisation of parts of the economy in the lower quality range. • Frequent changes in innovation policy. • Limited public recognition of the benefits of science and technology; some weaknesses in the culture of entrepreneurship. • Low graduation success rates in tertiary education.	• Failure to achieve high productivity growth, eroding competitiveness. • Stagnation of R&D intensity, notably in the business sector. • Failure to make full use of the country's rich human capital and knowledge base and loss of innovative edge in the face of global competition and sluggish domestic R&D. • Increasingly fierce competition for top international talent that compounds skills shortages due to an ageing population. • Offshoring of production and R&D activities of multinationals (corporate research centres). • Failure to diversity into sectors of growing global importance. • Cuts in public funding for fundamental and applied research.

1.3. Scope for improving and further developing innovation policy

The Netherlands has, in many instances and in various ways, been a pioneer in the development of innovation policy. Given its willingness to experiment and its enduring strong performance, it continues to provide examples of good policy practice. Nonetheless, there is scope for changes in specific areas to improve current performance and to ensure the sustainability of the Netherlands' leading position.

Most notably, despite signs of progress in recent years, policy has yet to tackle successfully the low levels of R&D activity relative to other frontier countries, especially, but not exclusively, in the business sector. Changes in policy approaches and in the policy mix have been frequent, against a background of a fair degree of political and economic volatility. The current thrust of innovation policy rests on two pillars: providing framework conditions conducive to innovation for all businesses and the "top sectors", a form of new industrial policy introduced in 2011 which applies to a selection of nine sectors (Box 1.1).

Box 1.1. The top sectors approach to government policy for the business sector

Motivated by concerns over international competitiveness and emerging social challenges the Dutch government announced the top sectors approach in February 2011. This new form of industrial policy focuses public resources on specific sectors and promotes co-ordination of activities in these areas by businesses, government and knowledge institutes. The nine area chosen (which do not correspond exactly to industrial sectors in established classifications) represented strong economic sectors: agri&food, horticulture and propagation materials, high-tech systems and materials, energy, logistics, creative industry, life sciences, chemicals, and water. In 2011 these sectors accounted for over 80% of business R&D (96% in 2010) and for just under 30% of value added and of employment.

Whereas traditional approaches to industrial policy are government-centred, industry representatives are at the centre of the co-ordination process in the top sectors. For its part government undertakes to develop sector-specific policies across ministerial portfolios, including education, innovation and foreign policy, as well as regulatory burdens. The relevant policy also envisages reducing the administrative burden for businesses, uniting the henceforth disparate channels of public support to businesses with a one-stop shop for service delivery (the so-called *Ondernemersplein*).

The approach involves new forms of governance. So-called "top teams" composed of high-level representatives from industry, public research and government draft knowledge and innovation agendas which they submit to the government for consideration. The government then evaluates each top team's proposed agenda, which includes a strategic plan and suggested instruments relevant to the top sector. The government's evaluation takes into account the level of ambition, the degree of commitment of stakeholders, the degree of openness, the balance between social and economic agendas and the extent to which the objectives can be monitored and evaluated. The relationships and sectoral plans are then formalised in the top consortia for knowledge and innovation (TKIs) of which some top sectors have more than one.

The public budget allocated to the top sectors is difficult to calculate accurately as it comprises mostly public resources committed to other purposes which have been aligned with the top sectors approach. It is subject to co-funding from the EU and also incorporates the R&D funding dispensed by thematic ministries (e.g. Health, Welfare and Sport, Infrastructure and the Environment, Defence) and sub-national authorities. The Dutch government estimates that (excluding regional and EU funding) between EUR 1 billion and EUR 1.1 billion will be made available to the top sectors every year over the 2013-16 period. Of this only the TKI funding allowance (between EUR 50 million and EUR 130 million a year) can be clearly identified as additional funding. Between EUR 50 million and EUR 30 million a year are foreseen for specific education and labour market interventions, while EUR 700-900 million a year are foreseen for research and innovation.

The government's efforts to provide favourable framework conditions focus on streamlining the regulatory framework affecting all businesses, providing tax incentives for investments in knowledge, and instruments to improve the availability of finance, such as loans and credit guarantees.

The top sectors approach involves public-private partnerships (PPPs) along sectoral lines to facilitate co-ordination and rationalise government interventions in a way that maximises impact. Motivated by concerns over international competitiveness and emerging social challenges, the objective is to identify and address market and government failures that prevent these sectors from achieving their full potential and to prioritise R&D activities. While in principle the approach aims to concentrate government attention and resources on a few sectors, in practice the choice of nine broad sectors and the decision to use public resources committed to other purposes means that the emphasis is more on co-ordination than on targeting.

1.4. Key issues and recommendations

Taking due account of the Netherlands' innovation-related strengths, weaknesses, opportunities and threats, a number of key issues have been identified and lead to some policy recommendations.

Maintain supportive framework conditions for innovation and entrepreneurship

Conducive framework conditions are essential for a country's overall innovation performance. Framework conditions that affect innovation, in addition to basic requirements such as macroeconomic stability and openness to international trade and foreign direct investment (FDI), include competition, the regulatory regime, intellectual property rights (IPR) and the tax system. For an advanced country to retain its position as a strong performer in innovation framework conditions must be world-class.

The Netherlands' macroeconomic situation has been difficult in recent years. The crisis hit in 2009, followed by a pronounced downturn that was, however, less sharp than in other countries. Yet the Netherlands did not rebound as quickly as other countries in northern and central Europe, and the economy double-dipped in 2012. In contrast to Austria, Germany, Sweden and Switzerland, economic activity has not reached pre-crisis levels, and real GDP is 4% below its peak of the first quarter of 2008. The Netherlands is now gradually emerging from the recession. Growth is improving but remains weak as deleveraging continues, resulting in low consumer spending and weak lending to the corporate sector. A sluggish macroeconomic environment impacts on innovation activity, notably through tightened constraints on funding.

In many respects, the Netherlands has an excellent business environment, including for early-stage entrepreneurial activity. Many of the conditions relevant to business creation, experimentation and entrepreneurial activity are largely supportive. However, there seem to be some barriers to growth after the start-up phase. An important inhibiting factor seems to be the increased scarcity of bank lending since the financial crisis, especially to small and medium-sized enterprises (SMEs), combined with the limited role of venture capital in risk financing.

Overall, framework conditions for innovation and entrepreneurship in the Netherlands are supportive and have contributed to good economic performance. The Netherlands has continuously improved its business environment over time, lowering barriers to competition and easing entry and exit. There have been successive improvements in the barriers to entrepreneurship dimension of the OECD Product Market Regulations (PMR) index and its components. The time required to open and close a business is among the shortest among OECD countries. Bankruptcy laws are sufficiently favourable towards entrepreneurs. Although many Dutch consider becoming an entrepreneur an attractive career option, attitudes towards accepting business failures and giving them a fair second chance could improve. Labour market regulations for permanent contracts are relatively restrictive, and figure just after the first-ranking "access to financing" among the most problematic factors for doing business in the World Economic Forum's *Global Competitiveness Report 2013*.

The creation of young businesses plays an important role in innovation, including more fundamental and even "radical" innovations. The OECD's Dynamics of Employment (DynEmp) project, which covers 18 countries from 2001 to 2011, found that: i) for the Netherlands the share of start-up companies (those with more than one employee) is relatively low, and is declining over time, as for other countries in the sample; ii) Dutch companies do not grow very dynamically as they age; and iii) the share of firms that never grow beyond one employee is among the highest in each main sector (manufacturing, business services and construction), and the highest in construction. Other data point to a large share of people who consider starting a business, but who have relatively low aspirations for job growth. Taken together these findings suggest that while it is relatively easy to start a business, there may be barriers to growth. With low transaction costs, owing to the use of ICT and important network effects, optimal size in many new and creative industries may be smaller than for traditional businesses. Nevertheless, the most productive and successful companies should still find it attractive to scale up. Therefore, lowering or removing barriers to expansion should remain an important focus of policy.

Recent initiatives (e.g. the Ambitious Entrepreneurship programme) aimed at helping new business founders achieve their growth aspirations are welcome. Easing the costs of dismissal of permanent workers should also facilitate the experimentation that is necessary for an efficient selection among start-ups and the rapid growth of successful ones. Allowing more flexible re-allocation of experienced workers could create a more dynamic labour market that would give longer-tenured employees more incentives to change jobs. Indeed, the future availability of a technically skilled workforce is critical for dynamic firm growth.

Financial conditions affect firms' ability to obtain the resources they require. This is especially true for young and small businesses, which tend to be constrained by a lack of internal funding or collateral. Some of these businesses play an important role as a source of innovative business models and other innovations. Once successful on a small scale, they need well-functioning financial markets to help them grow and expand the scale and scope of their innovation activities. An environment in which it is easier for successful firms to scale up also creates better opportunities to experiment with new solutions and to innovate.

Credit conditions have been tight for SMEs since the beginning of the financial crisis. The SME lending survey of the European Central Bank shows that Dutch SMEs, anticipating possible rejection, are less likely to apply for credit than firms in comparable countries. If they do apply, they are less likely to get what they want. Credit standards for SMEs tightened in 2013 after easing in the previous two years. Moreover, interest rate differentials between SME loans and other loans have increased substantially since the crisis and barely lessened up to 2012. To compensate for the current reticence of the banking sector to provide funds, especially to SMEs, the government has set up various schemes to help them obtain credit. These instruments help to fill the gap due to the weak levels of lending by financial institutions, but they may be insufficient fully to offset them.

Evidence of the availability of early-stage risk finance in the Netherlands is mixed. Venture capital investment as a percentage of GDP – including early-stage – is roughly on par with some comparator countries in the EU but is far behind the leading countries. Banks, pension funds and insurance companies face obstacles for investing in private equity funds. This may negatively affect the pool of financial resources and may be at least partially responsible for the relatively small size of the venture capital market, especially for the seed and early stages. To address this shortcoming, the government has put in place several targeted financing facilities (fund of funds, regional development agencies, the growth facility), and is planning additional ones, such as an early-stage instrument and the business angels co-investment facility. The fund of funds and co-investment approaches are considered good practice owing to their reliance on private investors' expertise, incentives and resources. Involving business angels is also a welcome step, and taken together, these facilities have the potential to improve substantially the venture capital investment climate.

The Netherlands owes much of its economic success to its highly developed water, rail and air transport infrastructure. It also has a highly developed ICT infrastructure. Nearly all businesses, irrespective of size, have access to a broadband connection, either fixed line or mobile. More recent wireless technologies are, however, less pervasive than on average in OECD countries. Subscription prices tend to be rather high, generally in the middle or in the upper ranking of OECD countries. This mainly concerns the mobile and wireless market, but also the broadband segment for bundles with high data volume and the fastest connection speeds.

Recommendations

- *Maintain sustainable public finances as an important requirement for dynamic private and public investment in innovation.* In undertaking the required fiscal consolidation, *fully take into account the potential negative long-run effects of reducing investments in human capital and in basic and applied research.*
- *Improve the environment for experimentation by young firms by further improvements in product market regulation, e.g. as regards licensing and permits.*
- *Pay due attention to the role of a flexible and well-functioning labour market as a precondition for a competitive and entrepreneurial environment,* especially for allowing successful young businesses to scale up and find the required set of skills and quality in the workforce.
- *Furthermore, contain the cost of dismissals by an appropriate easing of employment protection of open-ended, permanent contracts;* this would help facilitate experimentation with business models and foster the reallocation of employment towards the most productive companies.
- *Encourage risk financing by continuing to improve the regulatory and legal environment.* In particular, consider alleviating restrictions on banks, insurance companies and pension funds for investments in alternative assets such as venture capital.

Improve public governance – steering and co-ordination

Overall governance

Like many other advanced OECD economies, the Netherlands has witnessed a steady expansion in the number and range of actors with an innovation policy stake: more ministries and agencies are today considered to have roles to play in supporting innovation; the private sector's role in formulating and implementing policy, for example through PPPs, has increased; and the research-performance landscape is increasingly fragmented, with more public research centres (and re-organisation of existing ones) and more firms performing R&D. The innovation policy landscape has been further complicated by the growing number of policy instruments deployed (and frequently changed) and by the increasing number of objectives pursued. The growing role of regions and the European Union in innovation policy adds an additional "multi-level" governance dimension.

Policy coherence is a major concern and raises various issues in terms of co-ordination. From a vertical, principal-agent perspective, agencies are accountable to ministries but many operate with significant autonomy, particularly if they have a research funding function. Horizontal co-ordination of ministries, particularly of the two ministries most active in innovation policy – the Ministry of Economic Affairs and the Ministry of Education, Culture and Science – is mediated through a range of fora, some internal to government but many involving several other actors. The Netherlands has a rich array of intermediary organisations that together provide space for consensus to emerge in a more "bottom-up" style (through the so-called Dutch "*polder"* process) than is typical in other OECD countries. As such, they moderate "top-down" steering efforts and provide for "negotiated changes" in innovation policy and its governance. At the same time, their influence can mean that necessary changes can be hard to achieve.

That said, there has been a great deal of change in Dutch innovation policy, in part as a result of the political and economic volatility of the last decade. Some of the policy changes are at the instrument level, such as the shift in the balance between the use of direct and indirect support measures for business R&D. Others are more institutional, such as the funding and governance of applied research institutes. The frequency of these changes has created some uncertainty and a certain yearning for greater policy stability. At the same time, there does appear to be some continuity in the objectives pursued and in the sectors singled out for special attention. For example, the sectors chosen for the top sectors approach, have clear antecedents in sectors prioritised during the Innovation Platforms and the Peaks in the Delta programmes.

Top sectors: rationale, trade-offs and vision

The top sectors approach (Box 1.1) was motivated by concerns over international competitiveness, particularly the difficulties faced by Dutch exporters for expanding into BRICs' markets. The rationale for the top sectors approach underlines the link between innovation and export performance and foresees a central role for innovation policy and its instruments. The approach also involves agenda setting in education, the use of foreign policy, and a focus on deregulation to facilitate new firm creation and on streamlining the business environment.

The approach has many of the characteristics of modern approaches to industrial policy, especially its focus on co-ordination and alignment, the principal role attributed to stakeholder demand (particularly the business sector), and the commitment to monitoring and evaluation. Monitoring and evaluation practices in the Netherlands are in fact extensive and relatively sophisticated by international standards. As an approach to innovation policy, too, the top sectors approach reflects current thinking to a considerable extent. Its ability to integrate interventions across government departments into innovation policy is in line with calls for holistic approaches that recognise the systemic nature of innovation. At the same time, the policy differs from other modern approaches in its emphasis on economic sectors (as opposed to tasks or activities) and the absence of a search process for new niches, which make it somewhat less dynamic than other forms of modern industrial policy.

It is fair to say that the approach has been the subject of some debate. Many of the concerns raised are familiar to almost any debate about selective industrial policy: the government does not have enough information to pick future winners, the process runs the risk of capture by well-organised interests, and co-ordination can be bureaucratic and inefficient. Some arguments take issue with specific aspects of the top sectors approach. Among them feature claims that a sectoral approach does not take account of global value chains, that it risks diverting resources from horizontal policies such as education, fundamental research and the provision of public goods, and that gains from co-operation by business and government can be overrated. Moreover, it has been argued that some aspects of the approach may undermine its own objectives. There are concerns with the selection of the specific sectors, the alleged lack of "critical mass" in the top sectors and the balance between small and large firms. A common objection to the current choice of sectors is that it is backward rather than forward-looking, especially in terms of emerging social challenges. Another objection is that it is predominantly technology-oriented, with insufficient attention to non-technological innovation and the role of social science. Policy makers are also called on to remain vigilant with respect to possible regulatory capture and increased heterogeneity of regulation across sectors.

It would seem that at least part of the debate stems from issues related to its rationale and to the vision projected for the future. Focusing on sectors of strength is not always compatible with increasing overall competitiveness. As such sectors are unlikely to be sub-critical compared to other domestic sectors, the argument appears to be that they need strengthening compared to the corresponding sectors of international competitors. It will be important to incorporate the needed international comparisons into mechanisms that monitor progress and evaluate the top sectors. A longer-term vision might say more about the type of economy that the Netherlands aspires to become and describe its qualities in terms that can be broadly recognised and accepted. It would therefore be desirable to strengthen the rationale for the approach and inject further nuance and clarity, including in the specification of links between the overall strategic vision and its intermediate objectives.

Progress in the top sectors

It is too early to assess the impact of the top sectors approach, as it has existed for only two years. The policy – notwithstanding a healthy debate – appears to enjoy broad acceptance, in part because of a general understanding of the need for long-term stability in innovation policy. The co-ordination of top sectors and the attention paid to this dimension at the outset stand out as positive features of the approach. There are high levels of awareness, engagement and enthusiasm from businesses in some top sectors and considerable progress has been made in embedding the approach into policy making and research planning. Some of those involved in the drafting of roadmaps report that the approach has created a new and positive dynamic in public-private co-operation. There are tentative indications that the public research system is becoming aligned with industry in the top sectors.

At the same time, there are indications of variable awareness, development and commitment in the top sectors. As the nature of co-ordination problems tend to vary among sectors (according, for example, to the composition of stakeholders), it would be profitable to use evidence collected in the course of monitoring and evaluation to facilitate learning and consolidate experience into actionable lessons. While the participation of SMEs has increased over the past year, their representation remains a challenge, especially for SME-rich top sectors such as creative industries and logistics. Merely having SME representatives on the top teams may not be sufficient, given the enormous diversity of this constituency; additional ways to solicit their views and shape agendas (such as open consultations and surveys) may be required.

Co-ordination of the kind that takes place in the top sectors seems useful for bringing about lasting changes in behaviour, such as facilitating co-operation with knowledge institutes and raising the scope and ambition of business innovation, including by performing more R&D. However, current indications are that the need to increase the intensity, scope and ambition of innovation may be a particular challenge in parts of the business sector that are not covered by the top sectors approach. Extending the approach – or at least the lessons that can be drawn from it – to other parts of the economy could strengthen its impact. This would be important to help safeguard the long-term dynamism of the Dutch economy and innovation system.

The government appears well aware of these limitations and is taking steps to adapt the approach. For instance, in view of the limitations of the sectoral focus, three cross-cutting themes (ICT, bio-based economy, nanotechnology) were introduced. To encourage the participation of SMEs, special co-funding regimes are available and dedicated efforts are made to increase awareness. There is also an increasing awareness of the need to reflect emerging social challenges – particularly through alignment with the EU's Horizon2020 programme – and to develop the regional planning dimension.

Looking to the future, efforts are needed to clarify the rationale of the top sectors, to find a more compelling vision, and to link public support to measureable progress.

Recommendations

- *Systematise learning from past experience and tailor governance arrangements to the specific co-ordination problems of each sector.* Some of these problems are not new but were present in previous innovation-oriented public-private partnerships (PPPs). It is important not to miss opportunities to accumulate valuable lessons and to tailor governance arrangements to the specific needs of each sector.
- *Refine the strategic vision for the top sectors approach and make a compelling, evidence-based case for sector selection and for the merits of government support.* To this end the link between the high aspirations of the approach and existing monitoring tools could be improved by introducing intermediate-level objectives. The continuation of government support could be linked to success in meeting these objectives within specific timeframes.
- *Consider extending coverage – or at least transferring valuable experience – to other sectors, in particular those with greater scope to improve the intensity, scope and ambition of their innovation activities.* A recent self-organised initiative by the construction sector to emulate the top sectors approach could be

instructive in this regard, providing pointers to how the approach can be extended to other parts of the economy.

- *Extend the monitoring and evaluation framework to take due account of effects outside the top sectors (i.e. full social cost-benefit analyses).* In particular, closely monitor its impact on the strong international performance of Dutch fundamental research.
- *Institute mechanisms to strengthen the dynamism of the approach in light of societal challenges, emerging technologies and changes in global demand. Among others this may include:*
  - Strong representation of smaller and entrepreneurial companies;
  - Use of part of top-sector funding for competitive identification of innovation activities that cut across the top sectors, e.g. multidisciplinary PPPs that could lead to new and valuable combinations of knowledge.

Maintain a world-class human resource base for science, technology and innovation

The Netherlands has a highly educated workforce overall. A moderately large share of the population has engaged in higher education, and various pieces of evidence, including the OECD's PISA and PIAAC assessments, attest to the high quality of education and skills. The Netherlands also enjoys moderately high shares of knowledge-intensive employment. Around 22% of its workers contribute to R&D, design, software, database and other knowledge-intensive activities. In this it is similar to Belgium and Sweden and not far from the leading country, the United States. Moreover, the share of employment in industries classified as knowledge-intensive (on the basis of their average propensity to employ tertiary graduates) is in keeping with the levels of Finland, Norway and Germany. A particular strength is the expansion of professional education in the universities of applied sciences (UAS), a level and type of education that is important for innovation and an area in which many OECD countries face difficulties.

While these strengths are considerable, there is also room for improvement in the availability of skills relevant to innovation. In line with the low levels of R&D expenditure and the importance of non-R&D-based innovation in the Netherlands compared to other advanced systems, the workforce has a low share of researchers and R&D personnel, behind most countries in the comparator group with advanced innovation systems. The Netherlands is also at the lower end of the comparator group for doctoral graduation rates. Technicians and associated professionals account for a somewhat smaller share of total employment than in most countries with strong innovation systems. Whether these lower levels represent shortages or are appropriate to the economy's current needs is a subject of debate, though it was estimated recently that an additional 30 000 technicians will be needed every year until at least 2016.

Tertiary education has expanded substantially over the last two decades but there are concerns over teaching quality, particularly in the UAS, where teachers' qualifications are considered low and dropout rates are high. Furthermore, universities will need to adapt to new types of students and their changing needs. An ageing population underscores the importance of increasing lifelong learning, improving female representation in science and engineering careers, and attracting global talent. In this regard, around 17% of 25-64 year olds in the Netherlands participated in education and training in 2012, a level above the EU28 average of 9%, but considerably lower than the 30% in Denmark and Switzerland.

To increase participation rates, the government intends to liberalise student grants and is considering the introduction of loans for part-time students. The Netherlands has relatively few female researchers, though progress has been made over the past decade. The main research funding agency, NWO, has a number of programmes to improve gender balance at all levels of the academic career. Dutch universities are increasingly internationalised: around one-third of research staff are foreign-born. However, more international students would be welcome. The government has developed an action plan to attract and retain such students, which includes measures such as simpler rules for foreign students to enter the Dutch labour market on graduation.

The government has introduced multi-year performance agreements with each university covering actions to improve their teaching. These actions include elevating the educational level of UAS teachers, concentrating on fewer courses for which an institution has existing strengths (profiling), and implementing teaching programme accreditation systems in the UAS. Implementation of these performance agreements is linked to changes in the university funding model, with 7% of the block grant allocation now tied to achieving performance targets. Though not overly generous, these funds can be used to allow universities to take action to improve their teaching activities. It is too early to assess the impacts of these agreements, but the steps taken to encourage universities to think strategically, to analyse their strengths and weaknesses, and to adopt strategic targets seem to go in the right direction. The government intends to monitor and evaluate the performance agreements and performance-based funding over the next few years, which is welcome.

As part of the top-sector policy, the government has established Human Capital Agendas to identify skills needs for individual top sectors, and has set up Centres of Expertise to strengthen technical education in the UAS and Centres for Innovative Craftsmanship in secondary vocational education colleges. These measures were followed by a "Technology Pact" for increasing the number of technically trained people in areas in which there appear to be shortfalls. Co-operation between higher education institutions and the private sector is one of the main aspects of this pact, which includes measures to promote science and technology in primary and secondary education, a fund to promote co-operation between business and education, 1 000 scholarships a year for engineering students offered by companies in the top sectors, and EUR 300 million a year for on-the-job technological training.

In sum, the Netherlands' substantial knowledge-intensive workforce and related economic activities suggest that comparatively low levels of R&D activity and, more generally, somewhat less new-to-the-world innovation than in other countries with advanced systems are not inevitable. Even if the country's lower scope and ambition in terms of innovation is a reflection of its current industrial structure, it is well placed to upgrade its human resources further and to diversify into economic activities that generate new-to-the-world innovation.

Recommendations

- *Extend the human capital agenda initiative to parts of the economy not covered by the top sectors.* Particular attention should be paid to other knowledge-intensive sectors, notably in services. This will be important for sustaining dynamism in non-technological innovation.

- *Strengthen the alignment between top-sector-related skills initiatives and the broader education policy agenda.* A close monitoring of the effectiveness of co-ordination in the skills agendas and other measures should enable systematic learning. A key policy task will be to draw broader lessons for national education policy from the top-sector-related initiatives.

- *Consider tying a larger portion of block grant allocations to multi-year performance targets.* If evaluations show that performance agreements meet their objectives in terms of improving teaching quality, consideration should be given to raising the performance-related component of the block grant allocation, perhaps to as much as 20% of the total.
- *Continue efforts to improve teaching quality in higher education institutions, particularly in the UAS.* These efforts should ensure the continuing relevance of teaching programmes to the needs of industry, particularly in the profession-oriented UAS, while strengthening generic skills such as innovation management and entrepreneurship. These institution-level efforts should be complemented by a national overview on the provision of teaching programmes so as to avoid "blank spots" in the national coverage of disciplines.
- *Further improve the availability of STI skills by stepping up efforts to facilitate lifelong learning, improve female representation in science and engineering careers, and attract international talent*. The Netherlands is already making good progress in each of these areas, but efforts need to continue to offset expected skills shortages caused by an ageing population.

Foster innovation in the business sector

The Netherlands has an innovative business sector. Large Dutch multinationals are among the world's leading innovators, with impressive technological capabilities and performance. A majority of Dutch firms reported innovation activity in the 2008-10 EU Community Innovation Survey (CIS) that was similar to that of other countries with advanced innovation systems.

The Netherlands has very high rates of patenting activity and is typically among the world's leaders, owing to the presence of some large, globally networked and probably highly efficient R&D spenders. It performs moderately well – even if not always among the leaders – in other measures of intellectual property that can be used as proxies of innovation, such as trademarks. OECD estimates suggest that, relative to other advanced innovation systems, R&D resources and patenting are strongly concentrated in the top ten firms. It is likely because of this that Dutch patenting productivity (number of patents per amount spent on R&D) leads the comparator group in terms of Patent Cooperation Treaty or triadic patent families applications by considerably more than Germany, the second most productive country in this regard. These observations appear to suggest that, despite its small size, the Netherlands has been well positioned to exploit scale economies in R&D.

However, knowledge capital investments and business R&D expenditure (BERD) as a share of GDP (commonly referred to as BERD intensity) are low compared to other countries with advanced innovation systems. While the reasons for the low business R&D are the subject of some debate, the prevalence of sectors that typically invest little in R&D certainly plays an important role. Indeed, OECD analysis suggests that, once sectoral structure is taken into account, BERD intensity is just above the OECD average. Nevertheless, even the corrected BERD intensity is behind most other countries with advanced innovation systems, with the exception of the United Kingdom and Norway.

There are some indications that, despite the high innovative propensity of Dutch firms overall, a smaller share of innovating firms than in other frontier countries engage in new-to-the-world innovation. Besides low R&D intensity, these include the relatively low share of researchers in total R&D personnel, the relatively low share of firms that report co-operation with universities and public research institutes (PRIs) and the relatively low share of firms that report international collaboration on innovation activities. These low levels appear to be more prevalent in certain parts of the Dutch business sector. The deficits in terms of R&D and university-PRI collaboration relative to other advanced innovation systems seem to be greater for firms larger than SMEs and in certain sectors, including some services sectors.

These observations suggest a contrast between generally large, R&D-driven and highly internationalised firms and parts of the business sector whose innovation activities tend not to look much beyond national borders or established markets. Even if this reflects the current strategic positioning of Dutch firms in specific economic activities, the country's long-term economic sustainability might be better served by efforts to extend the scope and ambition of a greater share of business innovators, as is the case in other countries with advanced systems.

The current policy mix of support to business innovation is dominated by R&D tax incentives. Additional support is available, particularly for smaller firms, through a range of loan and credit-guarantee instruments for innovation projects. Firms that belong to one of the top sectors can also count on support in the form of the TKI allowance and relatively easier access to public research.

Over the past two decades, OECD countries have increasingly implemented tax incentives for R&D, and in the Netherlands, tax incentives play a dominant role in the current mix of instruments to support business R&D and innovation. Like direct support for business R&D, tax incentives can be justified as a response to the tendency of the market to devote fewer resources to R&D than would be socially desirable. They can be advantageous over direct funding in that they allow firms to decide which R&D projects to finance. At the same time, there is growing evidence that direct support, if well designed, has strong impacts on R&D spending and productivity. Direct funding can be better targeted at parts of the business sector that need support, at a wider range of firms' capabilities and at the behaviour that needs to change (e.g. to foster capacity development, to raise the scope and ambition of innovation activity, or to get firms to collaborate).

The Netherlands places more emphasis on tax incentives, as opposed to direct funding instruments, than most other OECD countries, with the exception of Canada and Australia. Relief for inputs to innovation is channelled through the WBSO (Research and Development Promotion Act) and the RDA (Research and Development Allowance); the Innovation Box provides relief for licensing and commercialisation revenues. The budget for the WBSO and RDA for 2013 was EUR 698 million and EUR 375 million, and budget depletion in 2012 EUR 731 million and EUR 130 million, respectively. The WBSO is particularly beneficial to SMEs. This is due to its design, notably the ceiling and the fact that the first bracket is more generous. Evaluations of the WBSO have been generally positive and policy design has been responsive to their findings. A potential drawback to this reliance on tax incentives is that they do not distinguish among types of R&D and innovation and leave little room for influencing the scope and ambition of firms' innovation an apparent need for parts of the Dutch business sector. More generally, they may be less suited to support the longer-term and riskier innovation activities that markets typically fail to provide and that cannot be fully covered by public research but hold great promise in terms of future social and economic impact.

The availability of finance for SMEs has been of particular concern. SMEs receive considerable support in the form of R&D tax credits and generally seem well served by the current policy mix. They receive the majority of WBSO funding. In light of the difficult financial conditions of recent years, a number of other instruments supply innovation-related finance in the form of loans and loan guarantees. The schemes have been fine-tuned, usually through information gained from evaluations, to cater to different types of firms at various stages of their development. However, the take-up rate of loans and loan guarantees is not very high, as suggested by the amount of uncommitted funds. Moreover, the re-introduction of the innovation voucher scheme in some top sectors, at the request of entrepreneurs, signals a need for other types of innovation funding. Co-ordination within the top sectors and potentially beyond represents an opportunity to find out more about specific bottlenecks in firm finance and to take remedial action.

The current imbalance in favour of tax credits may constrain first-time innovators, which often require upfront, small-scale funding. Their needs are on the whole more likely to focus on design and engineering activities than on R&D. Given their strong links with industry, the UASs seem well placed to support the development of capabilities in firms that innovate for the first time. Current efforts to strengthen the research and innovation activities of UASs appear well timed and could be explicitly linked to this effort.

Considerable support is available to firms that participate to the top sectors. The top sectors approach seeks to encourage R&D, innovation and other knowledge-intensive activities in the business sector, to provide the requisite human resources and to lift sector-specific regulatory barriers. In addition to generic instruments, the top sectors have the SME innovation support top sectors (MIT), which gives the top-sector leadership a choice over the mix of instruments to support SMEs' participation in the top sectors: technical feasibility studies, knowledge vouchers, support for hiring experts, R&D co-operation projects, support for participation in innovation performance contracts (IPCs), networking activities and innovation brokers. Entrepreneurs in the top sectors welcome the MIT as an opportunity to tailor interventions to demand. However, as its current budget is small (typically EUR 2 million per top sector and per cross-cutting theme), it is unlikely to redress the imbalance between direct and indirect measures.

The top sectors also support collaboration on innovation between public research and businesses. The focus on world-class research and the involvement of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO) can help to ensure scientific rigour and high impact. Their involvement may also encourage firms with experience in new-to-the-firm and new-to-the-market innovation to extend the scope and ambition of their activities to the global level. However, care should be taken when aligning a large share of public resources for fundamental research on the top sectors. It will be important to monitor closely the impact on the international performance of Dutch fundamental research.

Over the longer term, raising the scope and ambition of a greater share of business innovators should be a key policy goal. It could improve the economic impact of their efforts, achieve a more balanced portfolio of strong innovators and thus strengthen resilience. It could encourage diversification into new economic activities and strengthen companies' in-house capabilities for innovation. It could also improve the responsiveness of the broader innovation ecosystem to the emergence of new activities, for instance in the supply of relevant skills and in government regulation. Strengthening the dynamism of top-sector policy will be an important part of this effort.

Recommendations

- *Raise the intensity, scope and ambition of business innovation.* Pay particular attention to the needs of firms that are already innovative (or otherwise knowledge-intensive) but collaborate little with knowledge institutes and conduct little R&D.
- *Rebalance the policy mix by complementing the current focus on R&D tax credits with competitive, well-designed direct support instruments,* e.g. for joint R&D projects with knowledge institutes, and instruments used in the top sectors approach, such as the MIT.
- *Foster stability and minimise the burden imposed on businesses by frequent changes in the policy mix.* Predictability could be improved by linking major policy changes to system evaluation cycles agreed upon in advance (e.g. over five-year periods).

Foster critical mass, excellence and relevance in public research

The Dutch public research system consists of universities and a range of public research institutes. Universities accounted for around one-third of all research expenditures in the Netherlands in 2012. The PRIs performed around 10%. The Netherlands' binary university system is composed of academic universities (WO) and universities of applied sciences (UAS). The academic universities conduct scientific research, provide science- and research-based teaching, and promote the utilisation of research findings in society and the economy (so-called "valorisation"). The UAS are mainly oriented towards teaching that draws on professional practice.

Academic universities

The quality of research in academic universities is very high in international terms. For example, the citation rate of Dutch academic publications is the third highest after Switzerland and Denmark in a ranking of 18 countries. This research involves a high degree of international collaboration, which can be attributed both to the scientific excellence of the academic universities and to the Netherlands' relatively small size. Around one-half of Dutch scientific articles are published with an international co-author, somewhat higher than the OECD average.

External experts have evaluated the research of the academic universities since the 1980s. Evaluations occur at regular six-year intervals and address individual research units and the university as a whole. The results are used predominantly by university administrators for planning; they are not used by the government in funding allocation decisions, as in some other OECD countries. The research units also make use of the evaluation results to enhance their reputations, although grade inflation now means virtually all are rated good or excellent. Recent changes in the evaluation framework attempt to address some of the perverse incentives introduced by a reliance on scientific publication indicators. The number of evaluation criteria has been reduced to three – scientific quality, societal relevance and viability; the productivity criterion (i.e. number of publications) has been dropped, a clear signal that quantity is no substitute for research quality.

The source of research funding varies but is typically made up of three parts: a government block grant, indirect funding from research councils (NWO and KNAW), and contract research primarily from government organisations, the European Union and the private sector. As in many other OECD countries, the historical trend has been towards a smaller share of funding from block grants and a growing share of indirect funding and contract research. Indirect funding, particularly from NWO, is especially important for supporting fundamental research in the academic universities. However, grant proposal success rates in open curiosity-driven research calls have fallen markedly in recent years, to 17% in 2012, which is slightly on the low side by international standards.

Part of this decline can probably be attributed to a diversion of funds towards top-sector-related research calls, which also fund fundamental research on the condition that it is aligned with the knowledge needs of the top sectors. Top-sector-related investment is distributed across NWO's entire budget and is an integral part of NWO policy. In 2012 and 2013, NWO invested EUR 225 million a year in top-sector-related research. Its investment is set to increase to EUR 275 million a year from 2015 (out of a total NWO budget of EUR 625 million a year). Some of this top-sector-related funding is directed through public-private partnerships, and businesses are expected to make in-cash and/or in-kind contributions to research projects performed in the universities. However, the present requirements for business-sector commitments appear to be light as a whole.

Joint programming in the top sectors seems a promising way to encourage complementarity of public and business innovation investments and is in line with the Dutch government's view that more needs to be done to promote research "valorisation". However, several pieces of evidence suggest that Dutch universities are already well aligned with the needs of industry and have been for some time. In international comparisons, universities appear to attract a higher share of their funding from industry than in most other countries with advanced systems. Moreover, the Netherlands occupies a leading position among OECD countries in terms of international patent citations to national non-patent literature. The level of university-industry co-publications is also high, albeit below the levels attained in Sweden and Denmark. With this in mind, the policy drive for even greater valorisation of public research risks diverting the attention of top research universities away from the research frontier, which could jeopardise their strong international positions and capabilities. It may also approach the limit to what can be achieved in this area, unless it is accompanied by policies to institute lasting changes in the capacities and behaviour of parts of the business sector, too.

Universities of applied sciences

The UAS have limited research capacity, as conducting research was not among their original tasks and the teachers' educational level did not provide them with sufficient capabilities. The situation is gradually changing in both respects. In recent years, there have been efforts specifically to promote the research capabilities of the UAS and to utilise the knowledge generated for the benefit of SMEs. For example, the Regional Attention and Action for Knowledge circulation (RAAK) programme, a competitive flow of funds for practice-oriented research, has strongly stimulated co-operation between the UAS and employers; the Centres of Excellence programme has seen the establishment of several centres to promote research, teaching and knowledge transfer oriented to SMEs; and the appointment of more than 500 part-time research-performing lectors has provided an anchor for research and valorisation practices.

The results of these programmes seem positive and complement other public schemes to support knowledge utilisation in the economy and society. The measures are consistent with the aim of catering to the innovation needs of firms that may not be fully served by the more established academic universities. However, research activities still remain small-scale and, as such, benefit only a small part of the teaching and outreach activities of the UAS. They are also relatively new and will take time to develop their full research potential.

Public research institutes

There are three categories of PRIs in the Netherlands: scientific research institutes that fall under NWO and KNAW, government laboratories, and applied research (TO2) institutes, notably TNO (the Netherlands Organisation for Applied Scientific Research). From a policy perspective, the TO2 institutes are the more significant, with expenditures in excess of EUR 1 billion per year. The government's policy towards the TO2 institutes was recently rearticulated in a government position paper, "Our Vision of Applied Research", which proposes to make them more efficient and effective by changing their working methods and operational management. Wholesale reorganisation of the TO2 institutes appears not to be on the agenda for the time being, given the significant amounts of time and energy this would consume, not to mention the disruption. However, they face significant cuts in direct government funding over the coming years and are expected to align large parts of their research with the top sectors. By 2016, the TO2 institutes will receive on average only about one-quarter of their income through direct public funding (compared to around one-third in 2008), a rather low level by international standards.

It is worth recalling the purpose of this block grant funding: to provide a sound knowledge base that can be used to address immediate questions and to anticipate future questions and that allows the TO2 institutes to support the government in its policy and statutory tasks. Furthermore, independence is an important aspect of TO2 institutes' research as they support the public interest or implement public tasks. Cutbacks in block grant funding could compromise the long-term knowledge base of the TO2 institutes and their independence. Whether business will fund the core knowledge base of the TO2 institutes is doubtful and in some instances, where independence is required, may be undesirable.

Nevertheless, business is now expected to play a leading role in articulating demand for TO2 institutes' research through the top sectors, a role previously largely played by the government. The new arrangements somewhat restrict the institutes' autonomy, and there are concerns that they will lead to shorter time horizons and insufficient investment in infrastructure and development of competences. The government hopes that strengthening the links between applied and fundamental research will offset any tendencies towards short-termism and will help ensure that the institutes' knowledge is continuously renewed and updated through the application of the latest fundamental research. However, the extent to which such arrangements can compensate for reductions in dedicated public investments in the TO2 institutes' knowledge base is unclear.

At the same time, the lack of uniform evaluation arrangements, similar to those that apply to the universities, makes it difficult for the government to understand the outputs of the institutes and their quality and impacts. To this end, the government intends to introduce more uniform monitoring, measurement of effects and evaluation arrangements for the TO2 institutes. Every four years, starting from 2015, the effectiveness and quality of the institutes will be evaluated and compared, using the same criteria and procedures. Evaluation results will then be used as an input in determining the allocation of funding for the next four years. These proposals are broadly welcome and should also help the TO2 institutes better demonstrate the value of their activities to government ministries and other stakeholders.

Recommendations

- *Continue to nurture the high-quality research performed in the public sector.* This means maintaining healthy funding streams for fundamental research, particularly in NWO and KNAW. Avoid an overly strong focus on the top sectors, as this will limit the funds available for new topics and important research areas that are not directly relevant, with the risk that insufficient means are available for new areas and the pursuit of unexpected or risky topics.
- *Increase the contribution that business is expected to make to public-private partnerships.* The present requirements for business appear to be light, perhaps necessarily so while relationships and arrangements for PPPs still need time to develop. But the rules should be kept under scrutiny, with a view to increasing business commitments. It will be important to ensure that complementarity effects dominate possible crowding out.
- *Ensure that valorisation agendas are realistic and take sufficient account of the demand for public research from the business sector.* Insofar as the apparent shortcomings in collaboration are due to insufficiently ambitious forms of innovation in parts of the Dutch business sector, there is a danger of too much emphasis on supply-side measures when real bottlenecks persist in the absorptive capacity and behaviour of parts of the business sector. At the same time, it is important for policy to broaden its concept of valorisation, for example by acknowledging the multiple channels through which public research contributes to the economy and society, and to improve its measurement and evaluation accordingly.
- *Consider accelerating the development of research capabilities in the UAS*, ensuring their close alignment with the main teaching programmes.
- *Closely monitor the impacts of funding cuts and the top sectors on the TO2 institutes*, bearing in mind that, like their fundamental science counterparts, they require a certain level of stability and continuity, as well as a long-term perspective, for investment in core competences and infrastructure.
- *Ensure that the new uniform evaluation arrangements for the TO2 institutes respect the full range of their activities and outputs, as well as the considerable diversity of the institutes.* In particular, it will be important to avoid over-reliance on crude indicators, a particular risk when aiming for measurement standardisation across institutes.

Supporting international knowledge linkages

The Netherlands' long tradition of international economic and commercial linkages is reflected in the openness of the Dutch economy today. At the heart of western Europe, it benefits from close proximity to major markets and knowledge centres. It also has a highly internationalised science system, as attested by the high share of internationally co-authored publications.

The Ministry of Education, Culture and Science and the Ministry of Economic Affairs have recently developed national strategies to promote the international dimension of STI policies and programmes. The funding bodies KNAW and NWO play a role in defining strategic orientations and programming to support the internationalisation of STI. Individual universities and research organisations are also responsible for developing internationalisation strategies independently of national agendas.

Participation of Dutch science and innovation organisations in European Framework Programmes (FPs) is high compared to European averages. According to the latest FP7 monitoring report, the success rate of Dutch applications is significantly above EU averages (23% vs. 17%), although SMEs perform only slightly above the EU average. The government has acknowledged the opportunities arising from the Horizon2020 agenda, through the strengthening of linkages with the top sectors approach. Many of the EU grand societal challenges in the Horizon2020 agenda are directly related to some of the top sectors (energy, water and climate change, agri&food and food safety and security). A further alignment of the top sectors agenda and Horizon2020 represents an opportunity not only to facilitate top-sector participation in EU programmes, but also to encourage cross-sectoral exchanges with a greater potential for innovation.

Recommendations

- *Consider developing a co-ordinated national strategy on the international aspects of STI policy.* This could be jointly led by the Ministry of Economic Affairs and the Ministry of Education, Culture and Science and would promote co-ordinated action vis-à-vis internationalisation agendas more generally.
- *Continue to strengthen measures to increase the participation of Dutch SMEs in European programmes for science and innovation.* The focus on SMEs and the simplification of rules both in Horizon2020 and the top sectors approach offer an opportunity to target them specifically.
- *Continue to promote synergies between the top sectors and the Horizon2020 agenda while using European programmes to promote science and innovation more broadly, including for sectors and challenges not covered by the top sectors.* Establishing a stronger link between top sectors and societal challenges could make an important contribution in this regard. European programmes can also be an opportunity to connect internationally leading research teams active in non-top-sector research fields.

Strengthen regional innovation policy and co-ordination between different levels of government

Income inequalities between Dutch regions are relatively low owing in part to the polycentricity of the Dutch economy. No single province contributes more than 20% to aggregate national growth, a proportion much lower than generally observed in OECD countries. The regions have good levels of innovation intensity compared to OECD averages. The southern area of the country, in particular, hosts global innovation hubs.

Since the mid-2000s, regional development policy in the Netherlands has moved away from transfer mechanisms targeting lagging regions to investments in local strengths and assets. This shift coincided with the launch of the Peaks in the Delta programme, a national strategy with a territorial focus based on six local development strategies. These strategies identified opportunities and challenges in each regional innovation system, on the basis of existing strengths and clusters of activities. Despite the overall positive evaluation of the effectiveness and the efficiency of this policy, it was replaced by the top sectors approach, which marks a shift of policy focus from regions (regional and territorial development) to sectors (support for nationally selected sectors irrespective of location).

Regional and local authorities play an active role in the top sectors approach, however, especially in the support and promotion of leading regional clusters, SMEs, human capital and lifelong learning programmes. Furthermore, the south-east and the northern wing of the Randstad have been identified as key contributors to the top sectors agenda, owing to the concentration of top-sector-related activities in these areas. Several instruments associated with the top sectors approach – the SME+Innovation Fund, the centres of expertise, innovation-oriented procurement and the human capital agenda (each region has a technology pact that contributes to the national one) – have a clear regional dimension.

European funding and the proceeds from privatisations in the energy sector have provided opportunities for Dutch regions to develop, fund and manage regional innovation programmes, instruments and facilities. The top sectors approach increasingly acknowledges the importance of a constant dialogue between sub-national actors and the central government. Some of the risks related to national-regional programme misalignment are unnecessary overlap, omissions, fragmentation, and conflicting rules in programme design and implementation. The involvement of regional representatives in formal or informal steering groups associated with the top sectors could help to ensure that co-ordination is effective and that the needs of local actors are sufficiently taken into account. However, while such alignment is suitable for regions that specialise in the top sectors it is less so for areas specialised in other industries. The latter can develop smart specialisation strategies tailored to their respective strengths and assets and programme innovation activities using funding from the EU Structural Funds.

In addition to vertical co-ordination, top-sector policy may be an opportunity to strengthen inter-regional co-ordination in selected sectors, as well as cross-sectoral co-ordination at the local level to promote synergies and innovation at the intersection of different sectors. Between the top sectors and regional actors, dialogue and synergies can be promoted across firms located in contiguous areas and operating in different top sectors to identify opportunities for innovations that bridge thematic areas. In addition, inter-regional co-ordination may prevent the risk of disconnecting peripheral innovative clusters or firms from the core areas of activity in related industrial or technological fields.

Recommendations

- *Continue to engage regional and local authorities in the implementation and definition of regional aspects of top-sector policy (notably support for SMEs and the human capital agenda).* This will require the promotion of more active bottom-up consultations between multiple levels of government with the participation of regional and local representatives in steering groups and consultation teams.

- *Actively promote links between peripheral but innovative top-sector firms and leading clusters of activities.* It is important to ensure that innovative but isolated firms do not lack the opportunity to tap into national and international innovation networks.

- *Manage expectations regarding the alignment of the top sectors and regional innovation policy agendas appropriately.* Depending on the different regional specialisations, the alignment of top sectors and regional innovation agendas may be more or less appropriate. In addition, the non-alignment of some aspects of regional and local programmes to the top sectors may allow bottom-up initiatives to emerge.

Chapter 2

Economic performance and framework conditions for innovation in the Netherlands

This chapter discusses the Netherlands' macroeconomic performance. It presents salient features of the Dutch economy – openness to international trade, the important role of services – and sketches out patterns of structural change in production and trade. It also looks at the current state of framework conditions as they relate to entrepreneurship and innovation. It concludes with a brief discussion of the role of innovation in the country's longer-term economic development.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

On many accounts, the Netherlands is among Europe's most advanced economies. It is a founding Member of the European Union and is also part of the European Economic and Monetary Union (euro zone). The Netherlands looks back to a rich intellectual and economic history (Box 2.1).

2.1. Macroeconomic performance and productivity growth

Macroeconomic conditions are both a result and a determinant of innovation. On the one hand, a successful innovation system contributes to the efficient utilisation of resources, thereby raising productivity and promoting growth. More importantly, innovation can be viewed as the primary source of long-term growth in per capita income. On the other hand, a favourable environment, with strong and stable macroeconomic conditions, a healthy financial system and other positive features facilitates innovation and helps its diffusion across the economy.

Box 2.1. Aspects of the Netherlands' economic history

History, cultural and institutional characteristics, and geographical features have shaped the evolution of the Dutch economy, society and innovation system. A country with a population of 16.8 million (2013), which inhabits hardly more than 40 000 square kilometres, partly gained from the sea through continuous efforts, it is path-breaking in many ways. Dutch cities were early centres of European enlightenment and learning and contributed significantly to the advancement of knowledge and to economic, social and institutional innovations. Reflecting on its numerous achievements, including in finance, patenting, etc., eminent economic historians have called the Netherlands "the first modern economy" (de Vries and van der Woude, 1997).

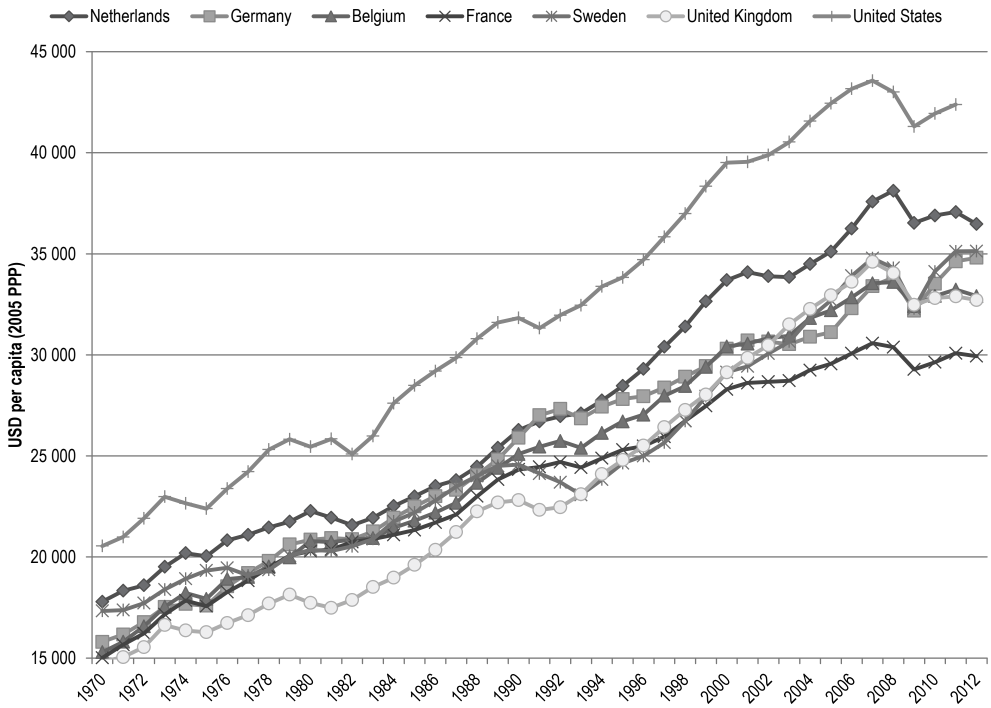
The Dutch economy has benefited greatly from globalisation, through international trade and investment, access to overseas markets, immigration, and the free exchange of knowledge. The achievements of the "golden age" of the Dutch republic of the 17th century created a strong science, technology and engineering base. For various reasons, the Netherlands dropped behind the world technological frontier around the time when England's Industrial Revolution was taking off (Mokyr, 2000). While it was not part of the first cohort of continental European countries to embark on the Industrial Revolution, the Dutch economy modernised in the latter part of the 19th century, laying the ground for many important industrial ventures that would eventually become large multinational enterprises with important implications for the future (Van Zanden, 1998).

Macroeconomic developments

In a long-term perspective, the Dutch economy has had comparatively high growth. The Netherlands' economic development after the Second World War was characterised by a period of high growth and catch-up with US income levels that lasted until the mid-1970s. Its economic expansion has not always been smooth, however. While GDP per capita was well ahead of that of European comparator countries in 1970 (Figure 2.1), its lead narrowed over time. A mismatch between productivity and wage increases started to appear in the 1970s, the effects of which came to be referred to as the "Dutch disease" and were exacerbated by the oil crises of 1973 and 1979. The situation was due in part to the negative side effects of the successful development of the gas sector, as real wage appreciation led to an erosion of competitiveness in other tradables.

Figure 2.1. Long-term economic performance

GDP per capita in USD (PPP) for selected OECD countries, 1970-2012



Note: GDP per capita at constant prices, constant US PPPs.

Source: OECD (2013), *National Accounts Statistics*, www.oecd.org/std/na/, August.

In response to this situation, the well-known Wassenaar Agreement – concluded in 1982 between business and labour unions, and later endorsed by the government – included a combination of cost cutting and institutional reforms, as well as incentives. The trade unions promised wage moderation and accepted more decentralised wage bargaining in exchange for a stronger emphasis on job creation. The government promised fiscal consolidation and lower taxes. As a result, real wages declined and increases in unit labour costs remained below the EU15 average. An increased role for the services sector (Wijnbergen, 1984; Corden and Neary, 1982) and diversification of exports also helped. The Dutch economy and productivity then rebounded and achieved rapid growth. During difficult times, the Netherlands proved to be resilient, owing to the population's willingness to take a pragmatic and consensual approach to confronting and adapting to changes in the economic environment and to related social, technological and economic challenges. The so-called "polder model" provided the institutional framework for much of the Netherlands' growth.

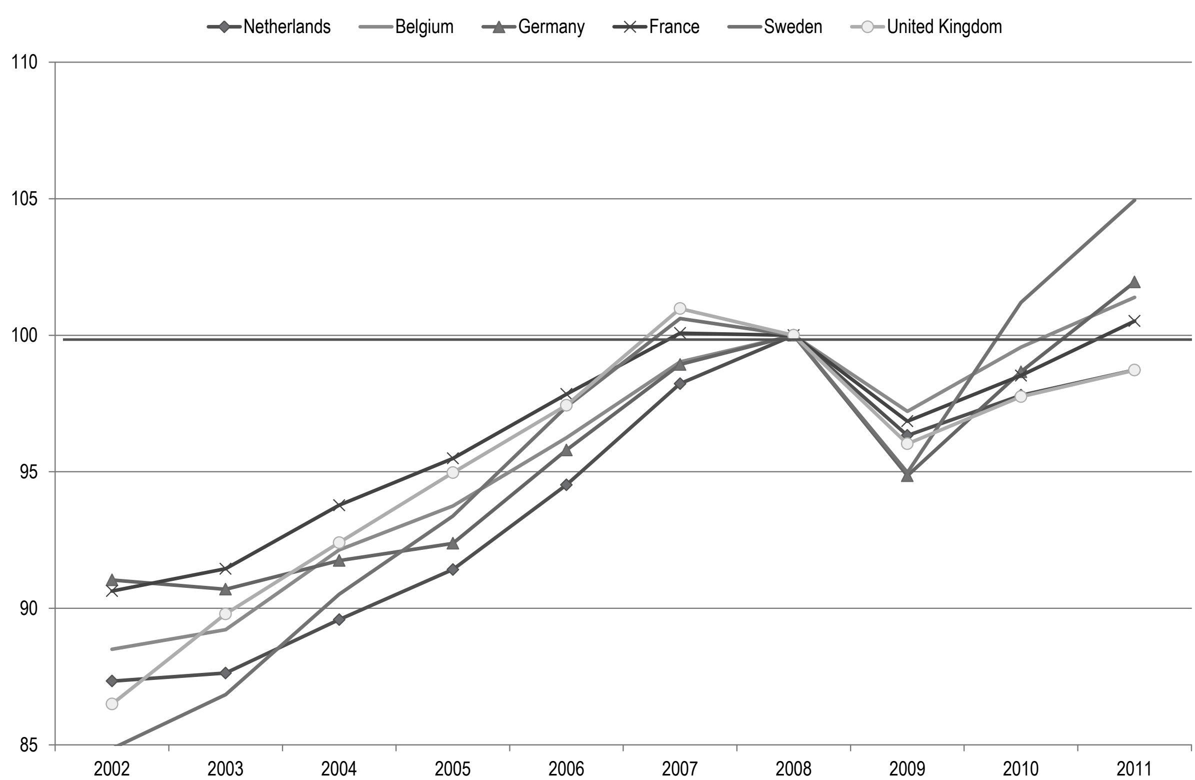
Subsequently, and although the country lost some ground, it managed once more to stay roughly on par with the United States in the 1990s, a significant achievement given the dynamism of the US economy during that period. The 1980s and 1990s were known in fact as the "Dutch miracle" (OECD, 2006). The international downturn at the beginning of the 2000s again affected the Netherlands, and in 2003 the Dutch economy was in recession. This was at least partly attributed to a deterioration in the competitive position of the Dutch economy (see the discussion of productivity and unit labour costs below).

Growth picked up again in the years preceding the 2008-09 crisis, and the Netherlands grew faster than many comparators. The crisis hit in 2009, leading to a pronounced downturn that was, however, less sharp than in other countries. Yet the Netherlands did not rebound as quickly as other countries in northern and central Europe, and the economy double-dipped in 2012 (Figure 2.2). In contrast to Austria, Germany, Sweden and Switzerland, Dutch economic activity has not reached pre-crisis levels, and real GDP is 4% below its peak in the first quarter of 2008 (OECD, 2014).

The Netherlands is now gradually emerging from a protracted recession. Growth is improving but remains weak as deleveraging continues, resulting in low consumer spending and weak lending to the corporate sector (OECD, 2014). An important impediment to a swift recovery has been the situation of banks and their diminished role in funding small-scale and risky projects. Moreover, signals about the capacity of the venture capital market to provide adequate financing to innovative businesses are mixed. These factors weigh on (short-term) growth prospects (OECD, 2014). To the extent that recent and ongoing fiscal consolidation affects resources devoted to education, research and innovation more broadly, it might also affect future innovation outcomes and weaken growth in the medium to long term.

Figure 2.2. Dutch economic performance before and after the crisis

Real GDP for selected countries, 2008 = 100



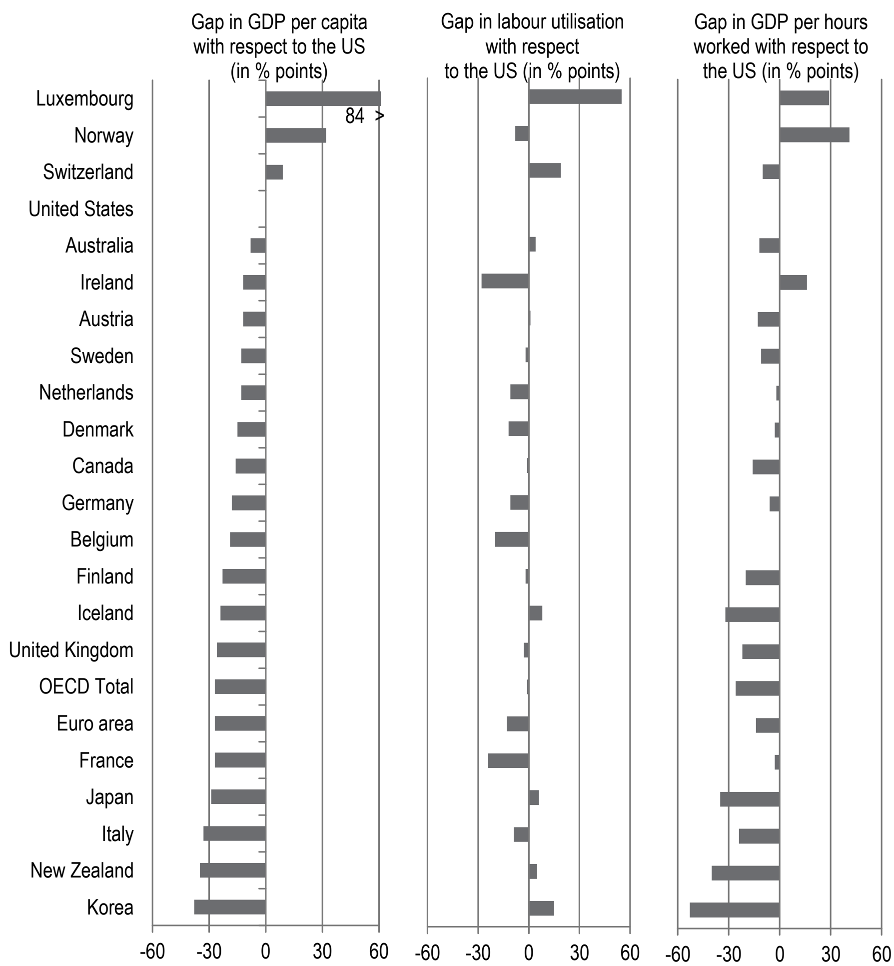
Note: Real GDP at constant prices, 2008 = 100.

Source: OECD (2013), *National Accounts Statistics*, www.oecd.org/std/na/, August.

Despite the weak rebound after the crisis, the Netherlands ranks ninth among OECD countries in terms of income per head, with a gap of 13% *vis-à-vis* the United States (Figure 2.3). Other OECD countries, notably small European ones, have similar levels of income per capita. Labour productivity – measured as GDP per hour worked – is just 2% below the level of the United States. Instead, the gap in GDP per capita is largely accounted for by labour utilisation – defined as the number of hours worked per working age population – which lags the United States by 11% despite high labour market participation (Gerritsen and Høj, 2013a and 2013b) and a relatively low, albeit rising, unemployment rate. The main contributing factors are the prevalence of part-time work, an early effective retirement age and a still high numbers of disability recipients, despite marked improvements (OECD, 2008; Sonsbeek and Gradus, 2013).

Figure 2.3. Income per capita and productivity

Income, labour utilisation and productivity levels relative to the United States for selected OECD countries, 2012



Note: Labour productivity and income levels are calculated using GDP at current prices and converted to US dollars using 2012 purchasing power parities. Labour utilisation is measured as total hours worked per capita. The euro area includes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, the Slovak Republic, Slovenia and Spain. France includes overseas departments.

Source: OECD (2013), *OECD Productivity Database*, www.oecd.org/statistics/productivity, August.

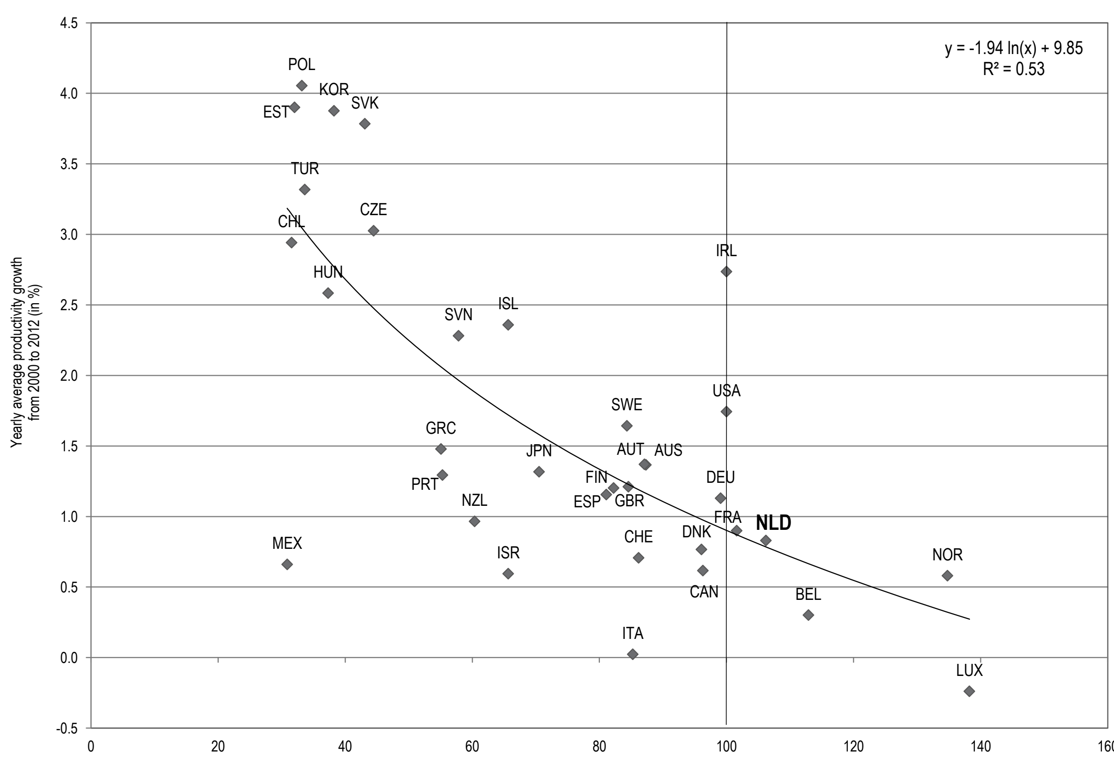
Productivity growth

Productivity is a main driver of economic development in the long term and the major source of differences among countries in terms of GDP per capita (OECD, 2013a; Figure 2.3). As labour market participation has a natural limit, higher labour productivity is the only source of sustained economic growth. This is especially relevant for developed countries such as the Netherlands, where demographic changes are expected to constrain labour market participation in the years to come. Labour productivity, in turn, is driven by capital intensity and multifactor productivity (MFP), i.e. the joint efficiency of the production inputs, labour and capital.[1] The broad picture emerging from the empirical literature is that it is MFP and not capital intensity that is more important for shaping countries' differences in income (Hall and Jones, 1999; for recent empirical work, see Inklaar and Timmer, 2009, and Johansson et al., 2013).

For the most developed countries, technological advances that push the technological frontier drive productivity growth. Countries further behind the frontier can realise immediate gains by adopting or imitating existing technologies (catch-up) if they have the absorptive capacity necessary to reap the "advantages of backwardness". Productivity growth is therefore likely to be slower for already highly efficient economies.[2] Through the 2000s, the Netherlands performed about as well as its high productivity level in 2000 would suggest (Figure 2.4).[3] Some comparator countries performed better than what would have been expected from their level of productivity.

Figure 2.4. Productivity levels and growth

Labour productivity levels (2000) and growth rates (2000-12) across OECD countries



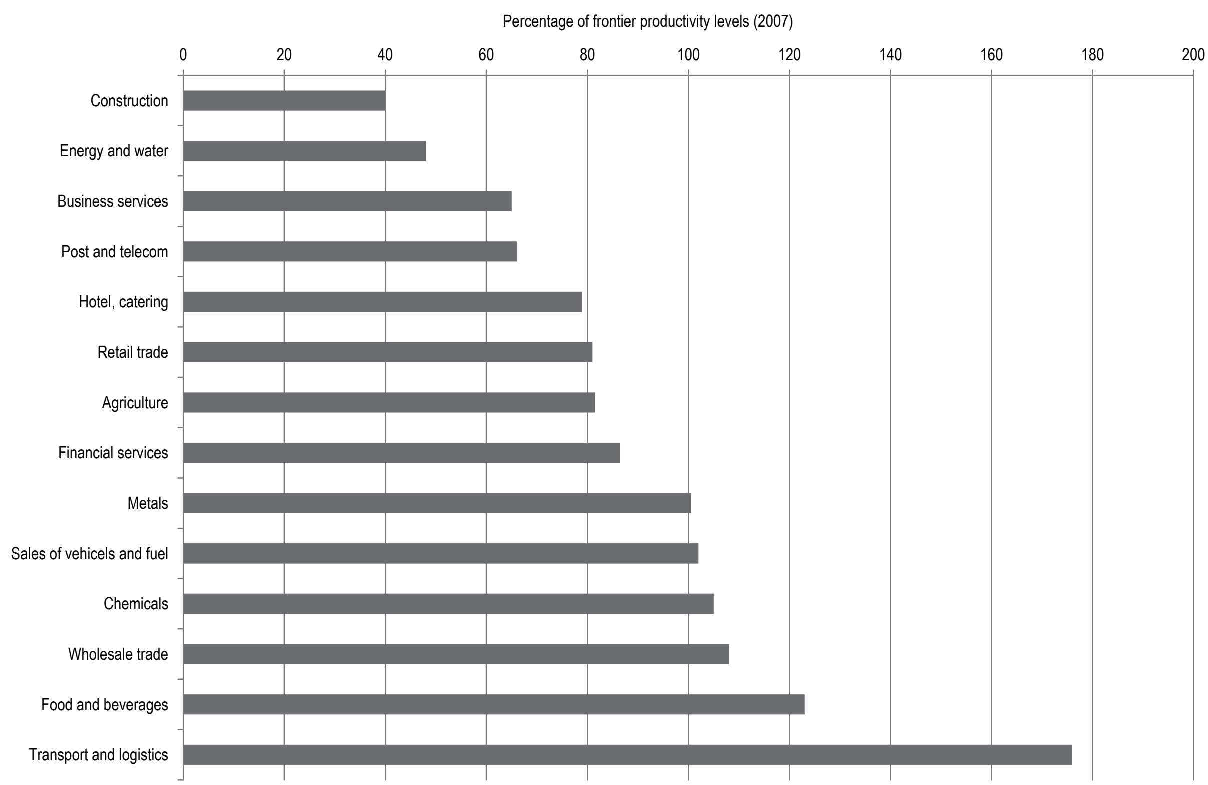
Note: Labour productivity is measured as GDP per hours worked, in USD, converted using PPPs.

Source: OECD (2013), *OECD Productivity Database*, www.oecd.org/statistics/productivity.

Contributions to the Netherlands' high productivity level vary across sectors and industries.[4] Transport, logistics and wholesale trade in the services sector and the food, chemicals and metals industries in the manufacturing sector stand out as being close to or at the global frontier (Figure 2.5). However, construction, the energy sector and, more importantly, the relatively large business services sectors still have a way to go to reach international best practices (Van de Ven, 2013). Challenges for the medium to long run include boosting productivity growth in laggard sectors, such as business services, telecommunications and construction, and keeping the best-performing sectors (transport, logistics, wholesale, food and chemical industries) at the international frontier through continuous innovation.

Figure 2.5. Productivity gaps across industries

Labour productivity levels by industry expressed as a percentage of the frontier, 2007



Note: The global frontier is defined, separately for each industry, as the average of the three best-performing countries in 12 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Spain, Sweden, United Kingdom). Small industries representing less than 1.5% of total value added are excluded.

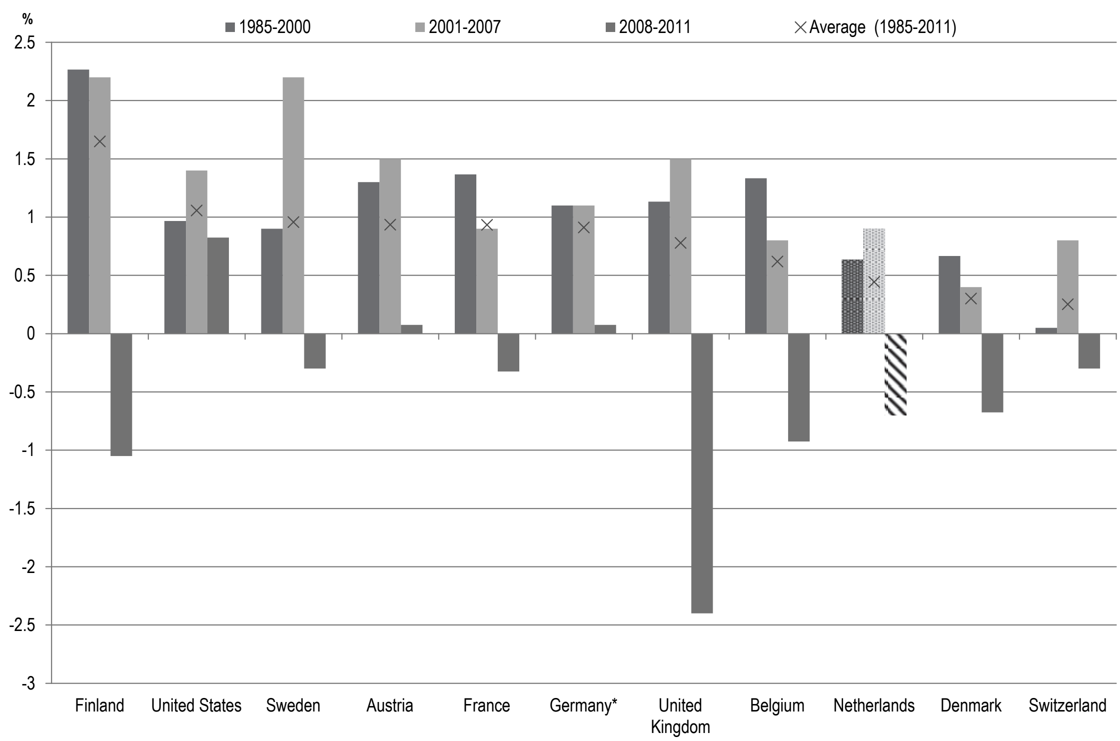
Source: OECD calculations following the methodology in Van de Ven (2013) using EU-KLEMS data (O'Mahony and Timmer, 2009) and detailed industry-level value added PPPs (Inklaar and Timmer, 2008).

High-performing transport and distribution activities are important in their own right. By reducing transport costs and delivery times, they are also the source of spillovers to many other parts of the economy. The outstanding performance of industries participating in foreign trade and logistics is critical for maintaining the Netherlands' position as a major logistic hub in Europe and reaping the benefits of its geographical location. Cross-country studies highlight the importance of a favourable geographical position for a high overall level of productivity. Boulhol and de Serres (2010) conclude that the benefits of a favourable location may be as high as 6% of GDP for Belgium and the Netherlands. Moreover, there is ample evidence of the importance of distance for trade and flows of foreign direct investment (FDI) (e.g. Nicoletti et al., 2003). Trade and FDI are also important channels for knowledge and technology spillovers (Eaton and Kortum, 1996; Keller, 2002).

While Dutch productivity levels are high overall, the country's MFP may raise the issue of their sustainability. MFP growth in the Netherlands has been one of the lowest among selected OECD countries in the last 25 years (Figure 2.6). The United States, Germany and Sweden have achieved higher MFP growth despite already very high levels of productivity, while Finland and Austria have caught up to the international frontier during the last decades. Only Denmark and Switzerland had lower rates of MFP growth than the Netherlands, and the MFP slowdown in the Netherlands since the beginning of the financial and economic crisis has been one of the sharpest among comparator countries.

Figure 2.6. Multifactor productivity growth

By country, average growth rates over selected time periods



Notes: *For Germany, data available only from 1995.

Source: OECD (2013), *OECD ProductivityStatistics* (database), www.oecd.org/statistics/productivity (October 2013).

Using a somewhat different methodology to calculate MFP growth, van Ark et al. (2013)[5] also find a slowdown during the 2000s. Indeed MFP has slowed down in advanced economies throughout Europe as well as in the United States (Fabina and Wright, 2013). The slowdown in most countries, including the Netherlands, is partly explained by the on-going structural shift towards services, which are usually less productive and improve more slowly. In addition, productivity growth in services has slowed as well and was a major factor in the aggregate slowdown.[6] Furthermore, OECD calculations show that MFP growth in manufacturing was lower in the Netherlands than in peer countries during 1995-2000 and 2000-08 (Table 2.1) and slowed between the two periods (i.e. before the onset of the crisis). In line with the findings of van Ark et al. (2013), there has also been a slowdown in trade and hotels, which has occurred in comparator countries as well. Exceptions are construction and agriculture, relatively small sectors, as well as business services, in which the Netherlands has shown accelerating MFP growth, despite a slowdown in other countries.[7]

Table 2.1. Multifactor productivity growth by sectors

2000-2008	Agriculture	Manufacturing	Construction	Trade and hotels	Business services
Netherlands	1.7%	2.5%	0.5%	2.3%	0.7%
Average of selected OECD countries	2.2%	3.1%	-1.1%	1.8%	1.3%
1995-2000	**Agriculture**	**Manufacturing**	**Construction**	**Trade and hotels**	**Business services**
Netherlands	-1.0%	3.2%	-0.6%	4.5%	0.0%
Average of selected OECD countries	3.4%	4.0%	-0.1%	2.2%	2.6%

Selected OECD countries are: Austria, Belgium, Denmark, Finland, France, Germany, Norway, Sweden, United Kingdom, United States.

Source: OECD “Productivity by industry”, *OECD Productivity Statistics* (database), doi: 10.1787/data-00627-en.

Slow productivity growth combined with disproportionately strong increases in labour costs raises unit labour costs (OECD, 2012). Over the two decades from 1991, unit labour costs in the Netherlands increased faster than in comparator countries such as Germany, Austria, Sweden and France. This tends to erode competitiveness and prevent better export performance. Slow productivity growth may also lead to a decline in GDP per capita in the medium to long term if productivity improvements do not compensate for a shrinking labour force that results from demographic change.[8]

There is an on-going debate among economists about the medium- and long-term outlook for productivity in advanced economies. Some argue that recent advances in information and communication technology (ICT) and their on-going diffusion are not enough to reverse slowing productivity (Fernald, 2012; Gordon, 2013). Others foresee tremendous increases in productivity as the use of sophisticated IT and robotic tools automate more and more tasks (e.g. big data, 3D printing). Others see emerging fields such as nanotechnology and biotechnology laying the ground for lifting productivity in services, particularly health care, as well (Bartelsman, 2013; Byrne et al., 2013; Brynjolfsson and McAfee, 2014). In any of these scenarios, the Netherlands, as a country that operates close to or at the technological frontier, will have to pay close attention to its innovation capabilities and performance.

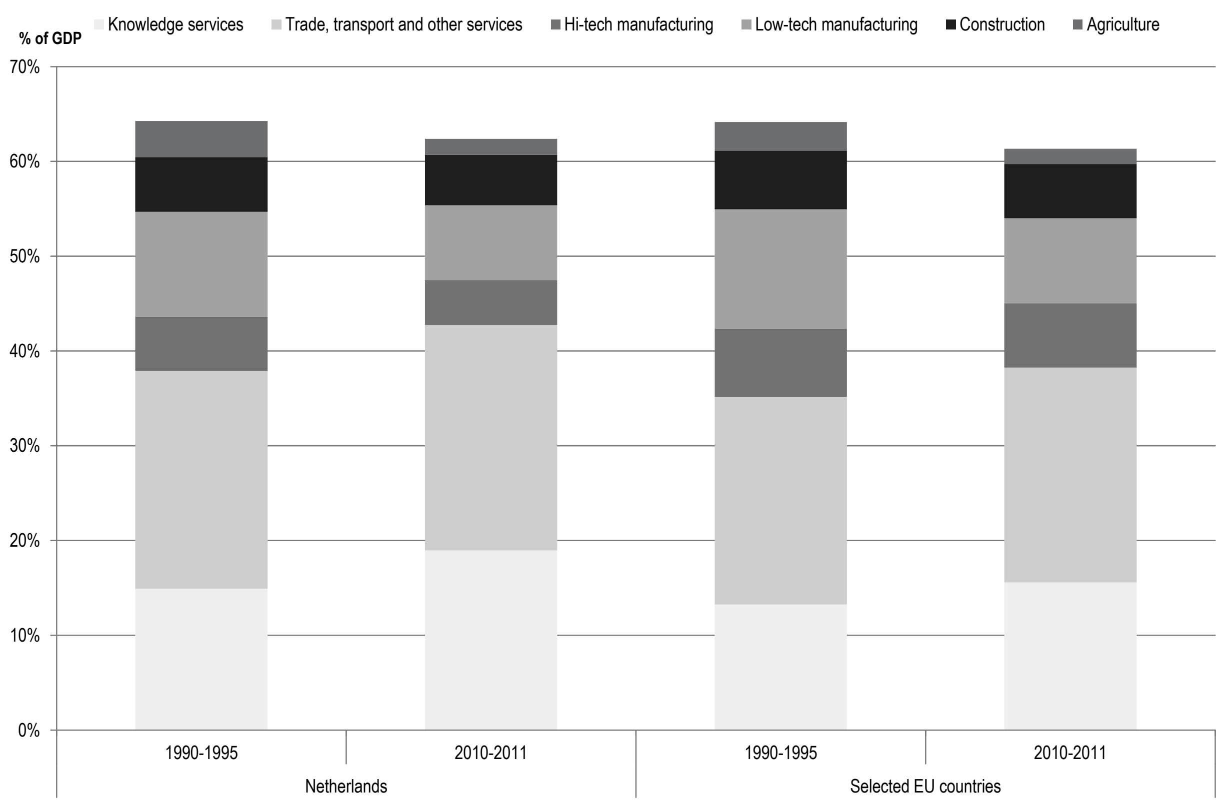
2.2. Globalisation and structural change

Structural change in production

The Netherlands has traditional strengths in the services sector in trade, transport and logistics owing in part to its geographical position – the Meuse and the Rhine rivers, good access to Germany – as well as financial and business services. These strengths can be traced back to Dutch cities’ early specialisation in trade and finance but they have, of course, evolved as a result of the institutional and technological changes that have underpinned globalisation, especially in transport and ICT.

Knowledge-intensive services play a strong role and have grown from 1990 to 2011 (Figure 2.7). In terms of value added, they accounted for 19% of the Dutch economy in 2011, 3% more than the average of comparator EU countries. Strengths in a number of industries notwithstanding, the manufacturing sector is relatively small and has declined over the last two decades to 13% of aggregate value added, against 16% in peers. The decline in the weight of the manufacturing sector in aggregate economic activity is a trend shared by other OECD economies, but it has been more pronounced in the Netherlands.[9] Moreover, both the low-technology and high-technology segments of manufacturing have shrunk, while there was almost no decline in the latter's share in comparator countries. These countries maintain a larger share of high-technology manufacturing industries. The traditionally important Dutch agricultural sector has seen its value-added share falling over time, as in other advanced EU countries. Finally, the role of the construction sector has remained roughly the same over time and is comparable to peer countries.

Figure 2.7. The share of major business sectors' value added in total GDP



Note: High-technology, low-technology and knowledge-intensity classifications are from Eurostat and based on R&D spending intensity at the 2- or 3-digit industry level. The public sector is excluded, along with some very small sectors (mining and quarrying; water and electricity) and the real estate sector. Selected EU countries include Austria, Belgium, Denmark, Finland, France, Germany, Italy, Sweden.

Source: OECD Structural Analysis (STAN) Database, ISIC Rev 4, www.oecd.org/sti/stan.

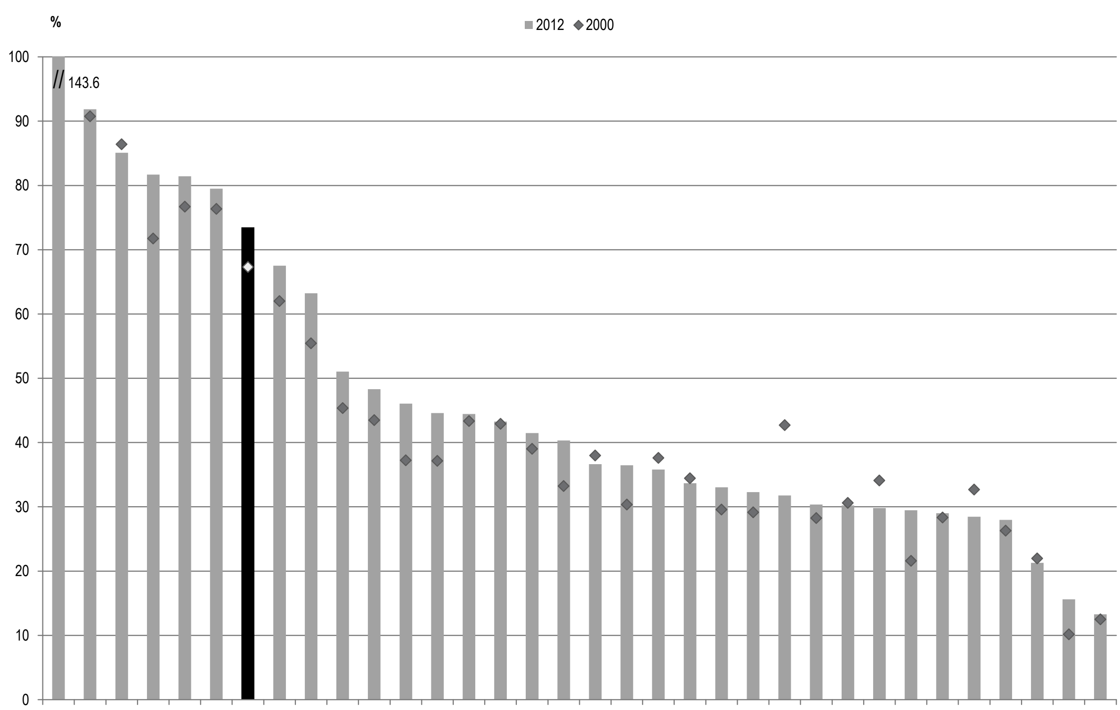
International openness: trade, global value chains and foreign direct investment

In addition to general macroeconomic conditions, openness to trade and integration into capital and goods markets are essential to an innovation-friendly environment. Trade openness may lead to scale economies by providing more opportunities for growth and may encourage innovation through stronger competition, while cross-border investments may transfer knowledge abroad and contribute to the spread of innovative practices (Box, 2009). In a small open economy in particular, foreign trade and FDI flows are of critical importance for economic growth and development (Keller, 2002). Historically, the Dutch economy owes much to its international openness. The Netherlands has derived much of its wealth from gains in trade and other international transactions. Over the centuries, its economic activity has gone beyond the confines of a relatively small domestic economy to access overseas markets. The Netherlands is one of the most open OECD economies – in fact it has become even more open in the 2000s (Figure 2.8) – and is tightly integrated into the global economy through trade and foreign investment flows. It also plays a key role as a logistics hub.

Openness to international trade (measured as the average of imports and exports of goods and services over GDP) is one of the highest among OECD countries, trailing only Luxembourg, Ireland and Belgium among EU comparator countries (Figure 2.8). Moreover, its openness increased in the last decade from 67% to 73% of GDP despite a substantial dip during the first year of the financial and economic crisis (OECD, 2012).

Figure 2.8. Openness to international trade

The average of imports and exports over GDP



Note: Includes goods as well as services trade.

Source: OECD, International Trade statistics.

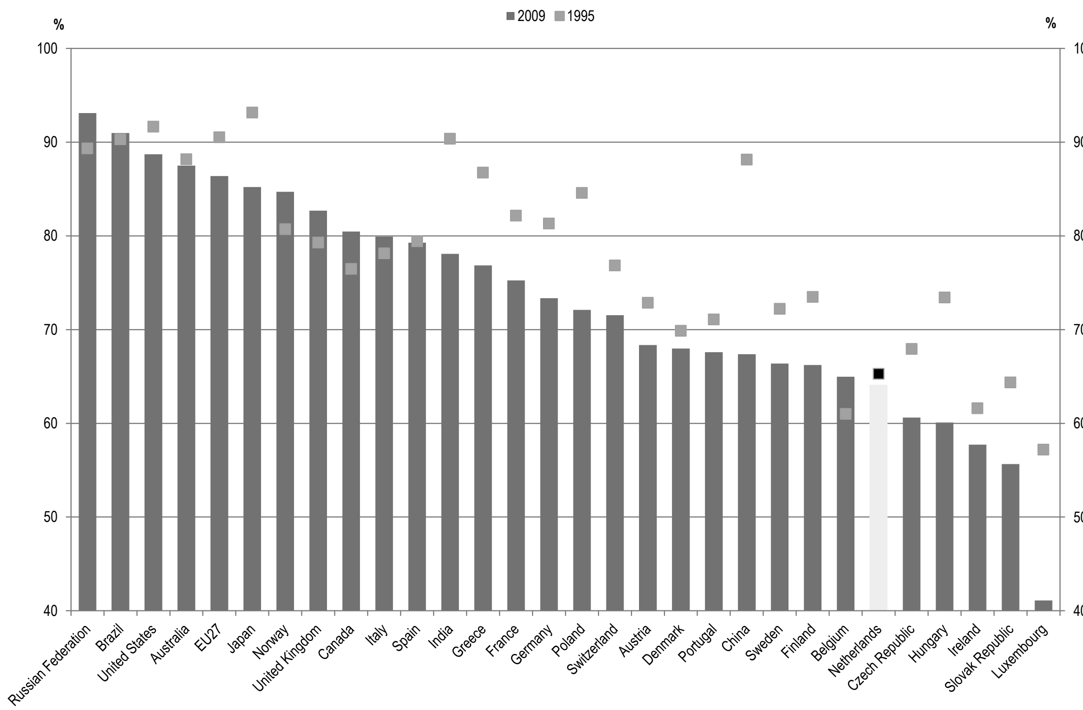
Dutch exports have grown rapidly in recent decades as world trade as well as intra-EU trade have expanded. The Netherlands is the second largest exporter among EU countries in gross terms, and recent data on trade in value added also indicate a very high degree of openness. Indeed, the export market performance of the Netherlands has been strong by international comparison. Unlike other OECD countries, the Netherlands has increased its export market shares over the past decades. However, this is largely due to the increasing re-exports of goods[10] – about 43% of total exports in 2012 (Statistics Netherlands, 2013) – with little domestic value added compared to domestically produced goods. Re-exports account for about half of exports to Germany, the Netherlands' main trade partner. Most exports are accounted for by a small number of large firms, as in other small open economies with large domestic enterprises (Statistics Netherlands, 2011).[11]

As in most other countries, the Netherlands' high degree of openness is primarily due to trade in goods rather than in services. Direct trade in services amounts to only 11% of GDP. Trade in services has increased along with exports of goods, and the contribution of services to domestic value added contained in exports has increased more than proportionately. When the indirect role of services as intermediaries in the production of export goods is also taken into account, their share doubles to 22% of GDP. The role of trade-facilitating services such as transport and wholesale and other knowledge-intensive services is very important and is reflected in a very high share of these services in total value added.

Integration into the global economy is taking place increasingly through global value chains (GVCs). Recent OECD work (De Backer and Yamano, 2012; OECD, 2013c) provides a basis for characterising a country's trade integration not only through the traditional industry dimension but also in terms of specialisation within GVCs. Trade in value added (TiVA) statistics indicate that the Netherlands, like Belgium, relies heavily on imported intermediaries and that the domestic value-added content of exports is relatively small. The share of domestic value added (which comprises direct and indirect exports) in gross exports is one of the lowest among OECD countries (64% according to the latest available data, for 2009) (see Figure 1.9). As a percentage of GDP, however, domestic value added embodied in foreign final demand (28%) is in the same range as in Sweden, Austria and Denmark.

Even though international trade flows continue to expand, links with dynamic emerging markets are relatively weak (OECD, 2012). Only about 5% of gross exports go to the BRICs (Brazil, the Russian Federation, India and the People's Republic of China), whereas e.g. around 10% of Germany's or Sweden's gross exports go to these countries (Figure 1.10). In terms of domestic value added content, the Netherlands share of exports to BRICs is higher than in terms of gross exports. This reflects indirect exports from the Netherlands to emerging economies through integration in value chains (e.g. intermediate inputs supplied to German assemblers which export to BRIC countries). However, the overall pattern remains that for the Netherlands the share of exports to the BRICs is lower than for European peer countries (with the exception of the United Kingdom). As a result, it may be difficult for trade expansion to drive future growth, as the traditional Dutch export markets are likely to continue to lose weight in overall world demand (Hausmann and Hidalgo, 2013). Future success in the BRICs will depend among other on the qualitative characteristics of the Dutch bundle of exports. The increase in unit labour costs has also exerted downward pressure on international competitiveness, as it has been, over the longer term, stronger than in other OECD countries.

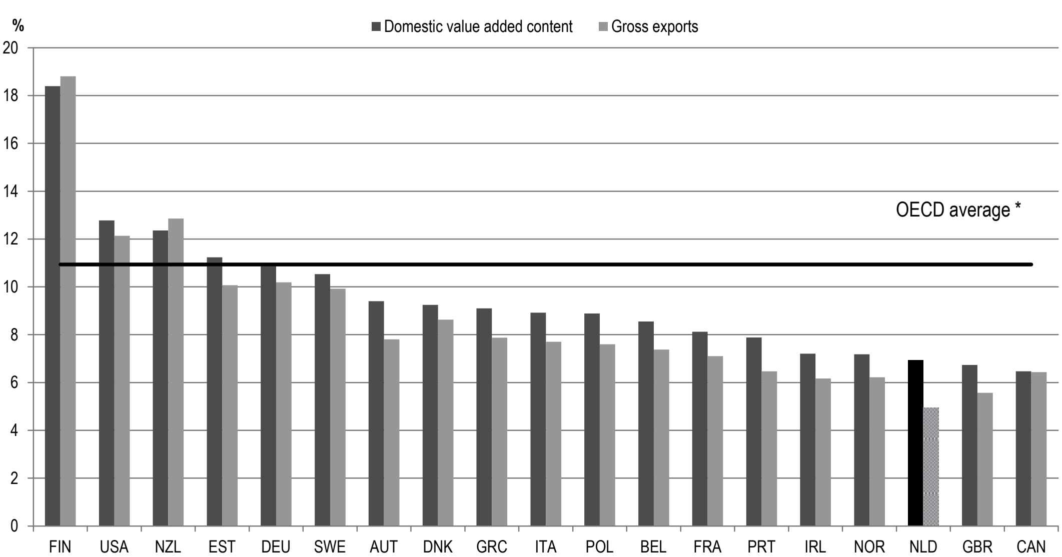
Figure 2.9. Domestic value added as a % of gross exports, 2005 and 2009



Source: OECD/WTO TiVA Database (2013), *OECD-WTO: Statistics on Trade in Value Added*, (database), doi: 10.1787/data-00648-en.

Figure 2.10. Exports to emerging markets, 2009

Gross exports and domestic value added content of exports to the BRICs as a share of total exports

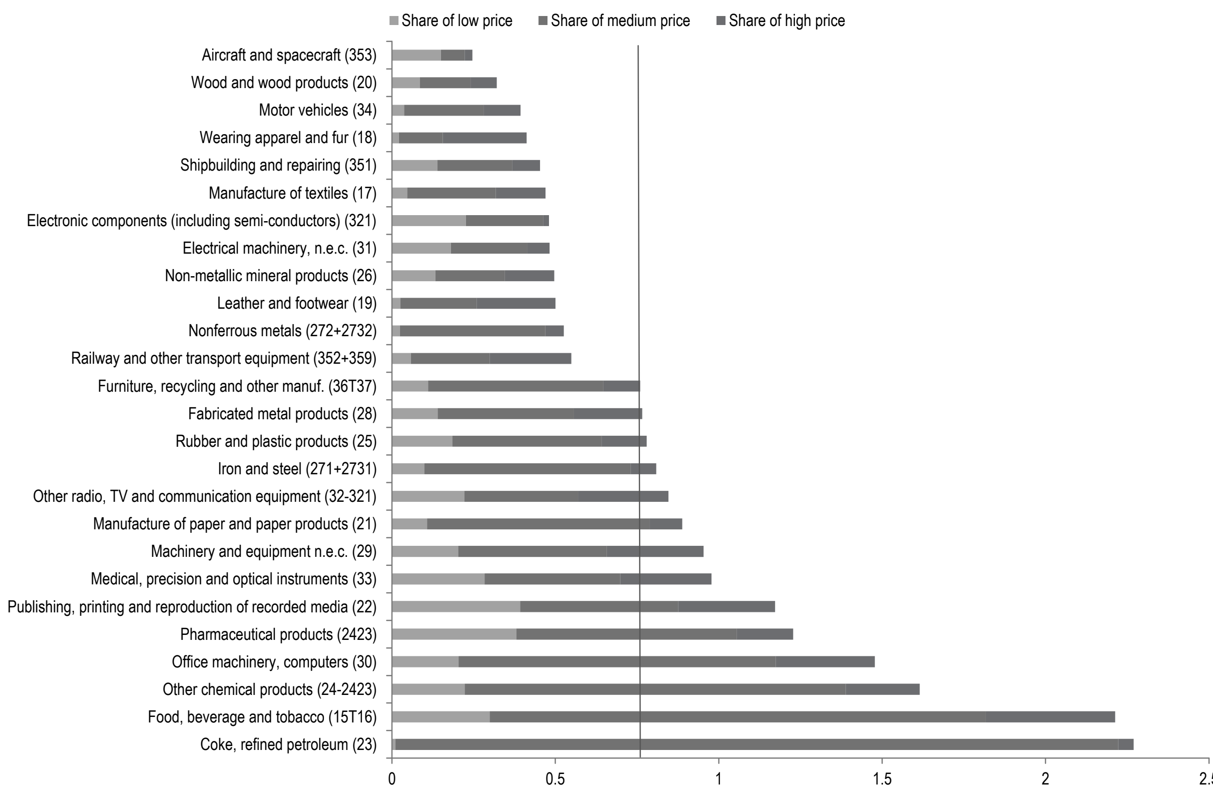


Note: Total exports of goods and services to BRICs as a percentage of total goods and services exports, in gross terms and in terms of domestic value added embodied in foreign final demand. BRICs: Brazil, Russian Federation, India and China.

Source: OECD/WTO TiVA Database (2013), *OECD-WTO: Statistics on Trade in Value Added*, (database), doi: 10.1787/data-00648-en.

The most successful industries in terms of export specialisation are food and beverages, chemical products, coke and refined petroleum, and office machinery, as shown by measures of revealed comparative advantage (RCA) (Figure 1.11).[12] Composition by price segments can serve as an indicator of the quality of traded goods (for a definition of the low (high) price segment see the note to Figure 1.11) although re-exports limit their use as a tool to characterise the sophistication of domestic economic activities.[13] Coke, refined petroleum and chemical products – the export sector with the highest value of the RCA index – do not show a specialisation in the high-quality segments suggesting a predominance of low-cost processing (and re-exports). Other sectors in which the Netherlands is specialised in (including food, beverage and tobacco but also office machinery and computers, publishing, printing and reproduction as well as machinery and equipment etc. have higher shares of exports in the high-price, high quality segment.

Figure 2.11. Revealed comparative advantage and export composition by price segments, manufacturing industries, 2010



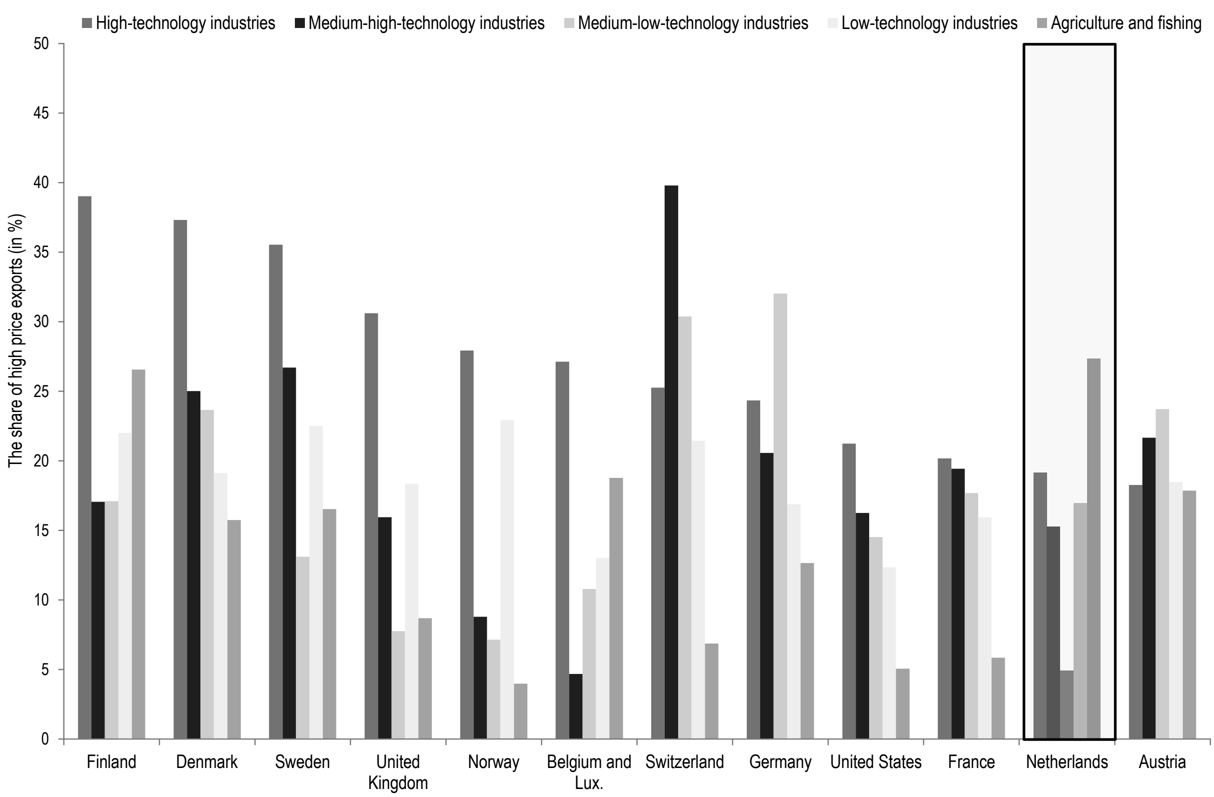
Note: The high (low) price segment is defined, approximately, as those export products whose unit values are above (below) the world average unit value by more than 25%. For an exact definition, see Cheptea et al. (2008).

Source: OECD calculations based on the CEPII-BACI database; Gaulier and Zignano (2010).

Cross-country comparisons of indicators based on export prices (unit values) suggest that high-quality segments have a smaller share of manufacturing exports than in peer countries. Typically, the most advanced economies focus on the most valuable products, especially in high-technology manufacturing (Figure 2.12). The Netherlands, however, seems to have a relatively low share of the high-price segments in each manufacturing subfield.[14] However, in the agricultural sector, more than 25% of products are in the high-price category, partly because the sector's economic strength and innovation capability enables it to be competitive in the highest-value segments.

Hausmann and Hidalgo (2013) identify agriculture products and chemicals as the main source of comparative advantage, based on existing export patterns. At the same time, they point to the weak contribution of machinery in comparison to other highly developed economies. Combined with increased competition from emerging economies in the low value-added segments and the on-going erosion of Dutch market share in these segments (e.g. agriculture products), Hausmann and Hidalgo find that this specialisation may pose a serious risk to the country's future export success and earnings capacity unless it moves to more sophisticated export categories. They indicate that the knowledge base needed for such a shift may already be present in the Netherlands.[15]

Figure 2.12. The share of high-price exports by technological intensity, 2010



Note: Technology intensity classifications are from Eurostat and based on R&D spending intensity at the 2- or 3-digit industry level.

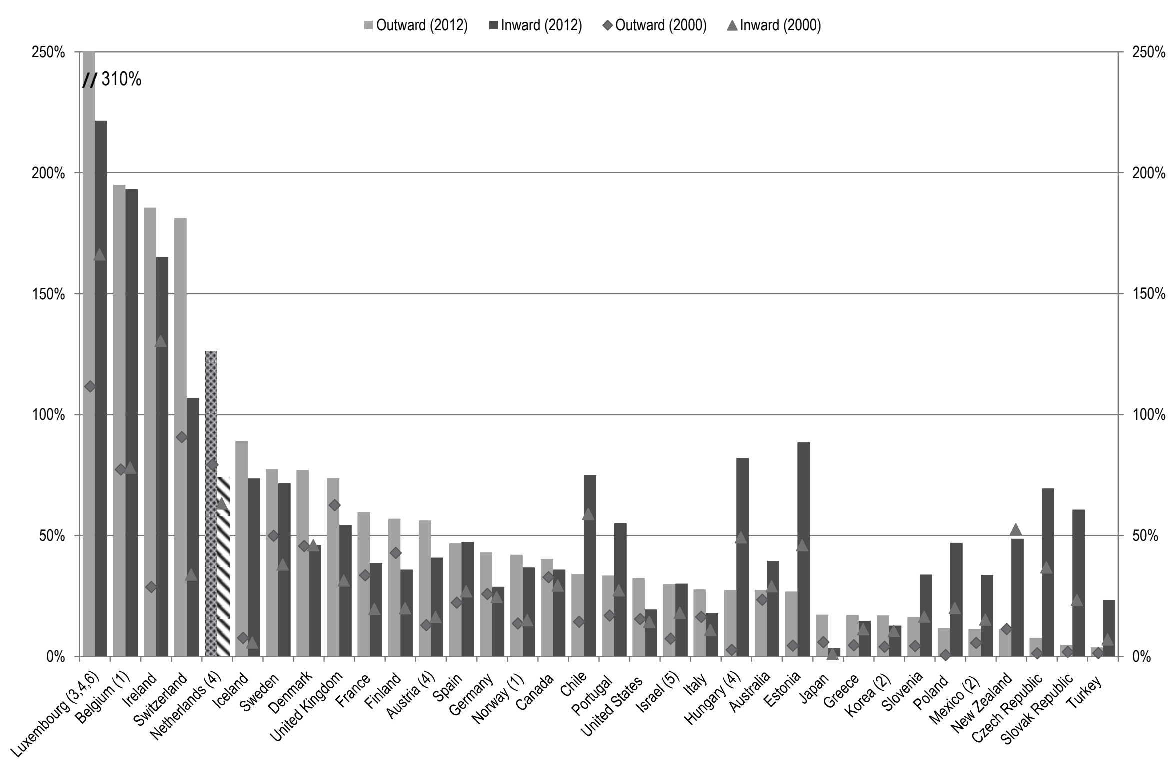
Source: OECD calculations based on the CEPII-BACI database; Gaulier and Zignano (2010), "International Trade Database at the Product-Level. The 1994-2007 Version", *CEPII Working Paper*, No.°2010-23.

As noted above, and in line with the Netherlands' role as a major European logistics hub, more than 40% of exports are re-exports. Moreover, "Dutch re-exports are still much more high-tech intensive than Dutch-manufactured products" (Statistics Netherlands, 2012, p. 37). Indeed, most Dutch re-exports consist mostly of high-technology products. As one may expect, while more "sophisticated", re-exports contain a lower share of domestic value added than domestically manufactured goods. Every euro of re-export adds only 7.5 cents to the Dutch economy, as compared to 59 cents for every euro of export of Dutch-manufactured products (Kuypers et al., 2012; Statistics Netherlands, 2012).

Foreign direct investment can affect a country's innovation performance both directly and indirectly. It can boost host countries' productivity because firms receiving FDI often gain in efficiency through the transfer of technology, better organisational and management practices, human resources, or better integration in supply chains and international markets. In addition, knowledge spillovers may lead to efficiency improvements in the wider population of domestic firms. These improvements may occur in the same sector, in upstream or downstream firms (suppliers or customers), or in regional innovation networks involving foreign-controlled firms. FDI can also stimulate innovation indirectly, e.g. via increased competition.

The great degree of openness in international trade is also reflected in the Netherlands' position in terms of international investment. The outward and inward FDI stock, as a fraction of GDP, is one of the highest among OECD member countries, after Luxembourg, Ireland, Switzerland and Belgium. However, it is important to bear in mind that these numbers are heavily influenced by the choice of location not only for production but also for headquarters and special financial institutions (OECD, 2014).

Figure 2.13. The stock of outward and inward FDI as a % of GDP



*Notes: (*1) 2011 instead of 2012; (2) 2001 instead of 2000; (3) 2002 instead of 2000; (4) data excluding special purpose entities (SPEs); (5) the statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law; (6) high FDI/GDP ratios observed in recent years are largely due to the creation of the Arcelor Mittal group.

Source: OECD International Direct Investment Database, OECD/DAF Investment Division.

2.3. Framework conditions for innovation and entrepreneurship

The role of framework conditions

The macroeconomic and general business environment, product and labour market regulations, the intensity of competition, business finance, the level and quality of entrepreneurship, the tax system and infrastructure all influence a country's innovation performance. Good framework conditions and a healthy business environment are key prerequisites for strong performance in innovation. There are several reasons for the importance of framework conditions:

- Innovation activity requires a medium- or long-term horizon and a sufficiently stable environment in which to carry it out. This is particularly important for R&D and more fundamental types of innovation activity.
- The regulatory framework is of crucial importance for the generation of new technologies and for the speed of their diffusion. Developments in the telecommunications sector in recent decades have demonstrated this.
- When framework conditions are of insufficient quality, they are likely to reduce the effectiveness of policies designed to foster innovation.

Favourable framework conditions facilitate innovation throughout the economy. However, OECD experience shows that "dedicated" policy measures are also needed to address specific market or systemic failures that hamper R&D and innovation. Empirical OECD work has found that both framework conditions and dedicated science, technology and innovation (STI) policies affect innovation performance, separately and in combination. This work has helped to identify the policies, institutions and framework factors that support innovation effectively (Jaumotte and Pain, 2005a; 2005b; Khan and Luintel, 2006; Box, 2009; Westmore, 2013).

Overall, framework conditions for innovation and entrepreneurship in the Netherlands are supportive and have contributed to good economic performance. This section considers the broad features of entrepreneurial activity and key framework conditions that support innovation in the areas of finance, infrastructure and product market competition. In many respects, the Netherlands has an excellent business environment: it is at the top among developed economies in terms of early-stage entrepreneurial activity (Xavier et al., 2013, Global Entrepreneurship Monitor, *GEM*). The overall attractiveness of framework conditions is confirmed by the Expert Survey in the GEM). However, there seem to be some barriers to growth after the start-up phase (Criscuolo et al., 2014). An important inhibiting factor seems to be the increased scarcity of bank lending since the financial crisis, especially to small and medium-sized enterprises (SMEs) (ECB, 2014), combined with the still limited – but growing – role of venture capital in risk financing (OECD, 2013g). The government is aware of the need to address the shortfalls in the area of finance, but the financial sector's resistance to risk taking is still likely to hinder the growth of businesses.

The most recent *Global Competitiveness Report* (World Economic Forum, 2013) puts the Netherlands in eighth place, down from the previous year's fifth place owing to the deterioration of financial conditions originating in the banking sector. It also refers to labour market issues (see below): dismissal regulations are relatively rigid for a leading economy, especially when compared to Denmark, the United Kingdom and Switzerland. However, the *Global Competitiveness Report* acknowledges that the Netherlands still has an outstanding education system, high-quality infrastructure, efficient product markets and a highly sophisticated business sector. The Regional Competitiveness Index (Annoni and Dijkstra, 2013) of the European Commission puts the Netherlands in first place among EU members, based on an assessment of regional indicators and the excellent performance of the Utrecht, Amsterdam and the area around Eindhoven.

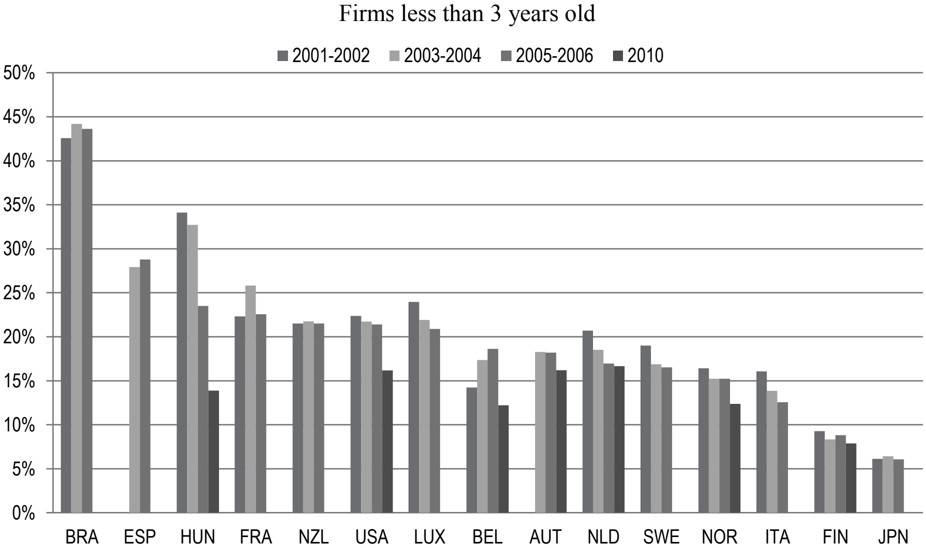
Stylised features of entrepreneurship

A growing body of evidence shows that entrepreneurship and the creation of young businesses play an important role in innovation (Lerner, 2010; OECD, 2013f), including the more fundamental or even "radical" innovations that are often pioneered by young, small enterprises, as older incumbents tend to make incremental innovation along established paths. A good overview and understanding of firm dynamics, especially in young enterprises, is therefore important. The OECD's Dynamics of Employment (DynEmp) project, with the participation of national contacts with access to the most complete source of company information (business registers), has recently led an extensive micro-data collection effort. It has gathered new information on employment dynamics for 18 countries from 2001 to 2011, by firm size, age and industry (Criscuolo et al., 2014). For the Netherlands, three of the project's results are particularly important:

- First, the share of start-up companies (those with more than one employee) is relatively low in the Netherlands, and is declining over time, as for other countries in the sample (Figure 2.14).
- Second, Dutch companies start relatively large but do not grow very dynamically as they age (Figure 2.15), confirming a widespread concern about apparent barriers to growth.
- Third, the share of firms that never grow beyond one employee is among the highest in each main sector (manufacturing, business services and construction), and in fact leads in construction, echoing the prevailing view that there are many self-employed in these sectors (Figure 2.16).

Figure 2.14 The share of start-ups

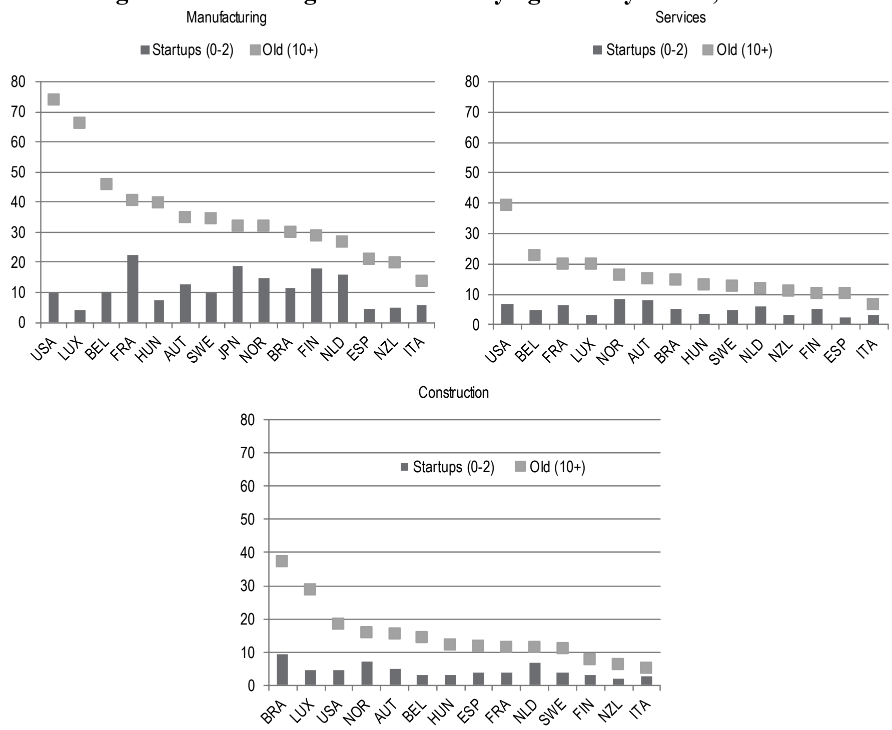
Firms less than 3 years old



Note: As a percentage of all firms in the total private business sector. Start-ups are firms aged from 0 to 2 years. Data for Japan refer to establishments in the manufacturing sector. For the Netherlands years 2006-09 are excluded from the calculations owing to changes in the process of compiling the Dutch business register. Data excludes firms with always one employee and appearing one-year only.

Source: Preliminary results from the OECD's DynEmp project (Criscuolo et al., 2014) based on national business registers.

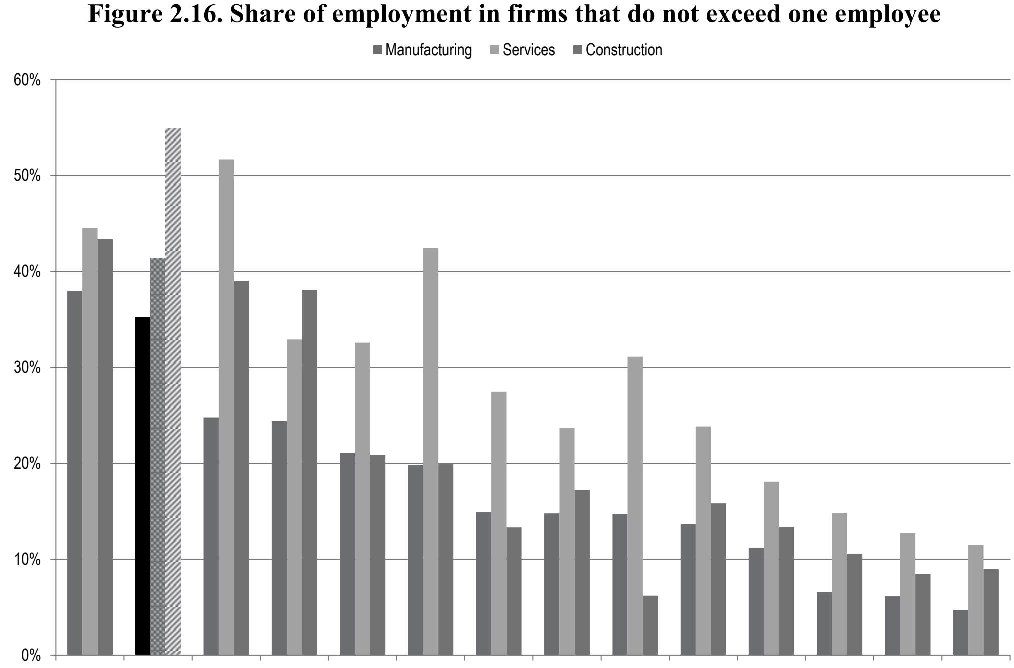
Figure 2.15. Average size of firms by age and by sector, 2001-11



Note: Size is measured as the number of employees, averaged over all firms in the age categories. Differences across business registers, especially the treatment of mergers and acquisitions, and inactive firms may influence the results. Firms that appear for only one year or that never exceed one employee are excluded.

Source: Preliminary results from the OECD's DynEmp project (Criscuolo et al., 2014) based on national business registers.

Figure 2.16. Share of employment in firms that do not exceed one employee



Note: Differences across business registers, especially in the treatment of mergers and acquisitions, and inactive firms may influence the results.

Source: Preliminary results from the OECD's DynEmp project (Criscuolo et al., 2014) based on national business registers.

Veugelers (2009) and Czarnitzki and Delanote (2013) argue that EU start-ups face high barriers to growth. They cite access to finance as one of the major reasons. Bartelsman et al. (2004) and Bravo-Biosca et al. (2013) confirm empirically that barriers to growth are relatively high. The hurdles young companies face discourage innovation.

Other sources, relying on surveys of individuals' entrepreneurial aspirations, indicate a high share of people considering starting a business, but with aspirations for job growth that are relatively low (Xavier et al., 2013, *Global Entrepreneurship Monitor*). Taken together – and bearing in mind the favourable regulatory conditions for the creation of businesses and the attractive tax treatment of the self-employed – these findings suggest that while it is relatively easy to start a business, there may still be barriers to growth. With low transaction costs owing to the use of ICT and important network effects, the optimal size of many new and creative industries may be smaller than for traditional businesses. Nevertheless, the most productive and successful companies should still find it attractive to scale up. Therefore, lowering or removing barriers to expansion should remain an important focus of policy.

The recently set-up Ambitious Entrepreneurship programme aims at helping new business founders in realising their growth aspirations and is a welcome initiative exactly in this spirit. In addition, labour regulation can also play a key role. Easing the costs of dismissal of permanent workers should also facilitate the experimentation that is necessary for an efficient selection among start-ups and the rapid growth of successful ones. While fixed-term employment contracts and subcontracted workers offer an alternative source of flexibility, these workers usually have lower skill levels or less experience (e.g. students). Allowing a more flexible re-allocation of the more experienced group of workers could create a more dynamic labour market, where longer tenured employees have more incentives to change jobs (Gerritsen and Høj, 2013a). Indeed, the future availability of technically skilled workforce is critical for dynamic firm growth. In that respect, the recent initiative (TechniekPact) is a step in the right direction.

Policy environment affecting entrepreneurship

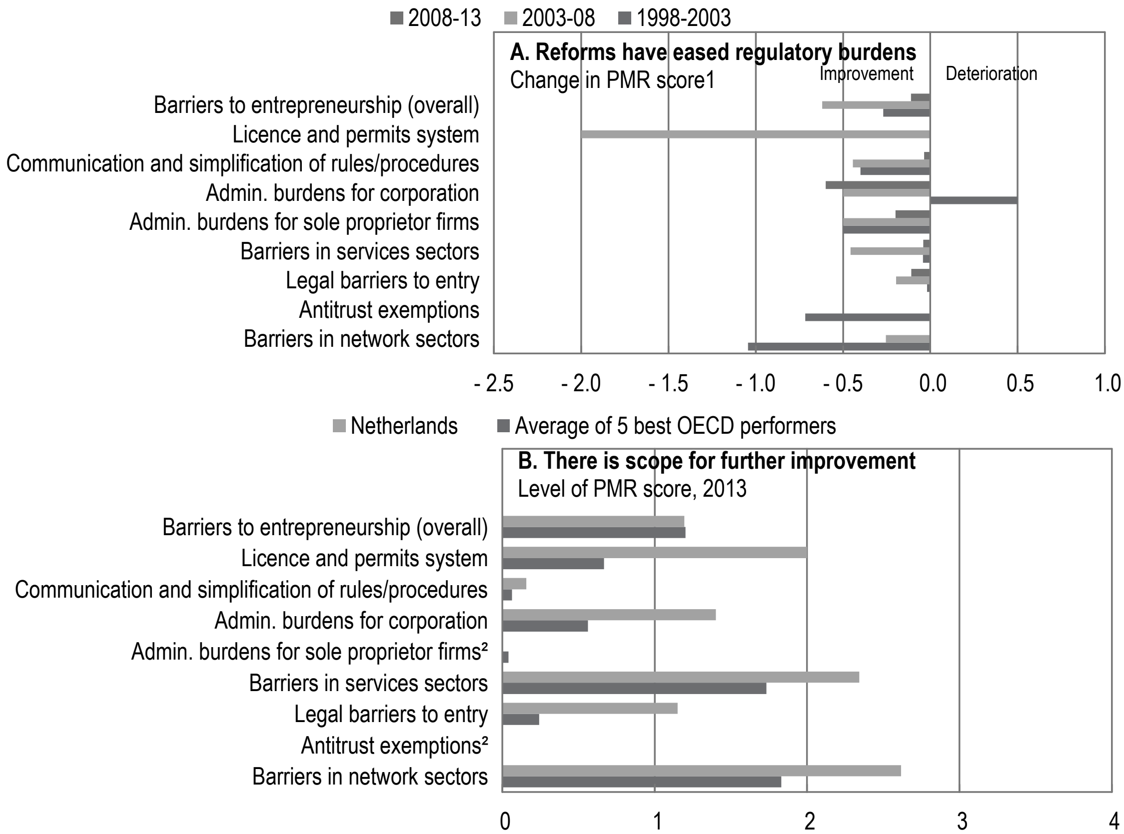
The Netherlands has continuously improved its business environment over time, lowering barriers to competition and making entry and exit less costly. Figure 2.17 shows successive improvements in the barriers to entrepreneurship dimension of the OECD Product Market Regulations (PMR) index and its components (OECD, 2014; Koske et al., 2014; see Box 2.2 below).

Despite significant improvements in the licensing and permit system, and in the area of administrative burdens for corporation, there is still a marked regulatory gap compared to the best OECD performers. The administrative burdens in particular may hold back firm growth and thus contribute to the symptoms described above.

In line with the favourable picture presented by the PMR indicators, other sources confirm that the time required to open and close a business is among the shortest among OECD countries. Bankruptcy laws are favourable (Andrews and Criscuolo, 2013; World Bank and IFC, 2013). The Netherlands is in sixth place in the World Bank's Doing Business ranking for the indicator on resolving insolvency: a high recovery rate, a relatively short time and a low cost to the estate.

Figure 2.17. Product market regulations: barriers to entrepreneurship

Index scale from 0 (least restrictive) to 6 (most restrictive)[1]



1. There was no change in the PMR score for the licence and permits system in 1998-2003 and 2008-13, for antitrust exemptions in 2003-08 and 2008-13, or for barriers in network sectors in 2008-13.
2. For administrative burdens for sole proprietor firms the PMR score of the Netherlands is zero (i.e. least restrictive). For antitrust exemptions the PMR scores are zero.

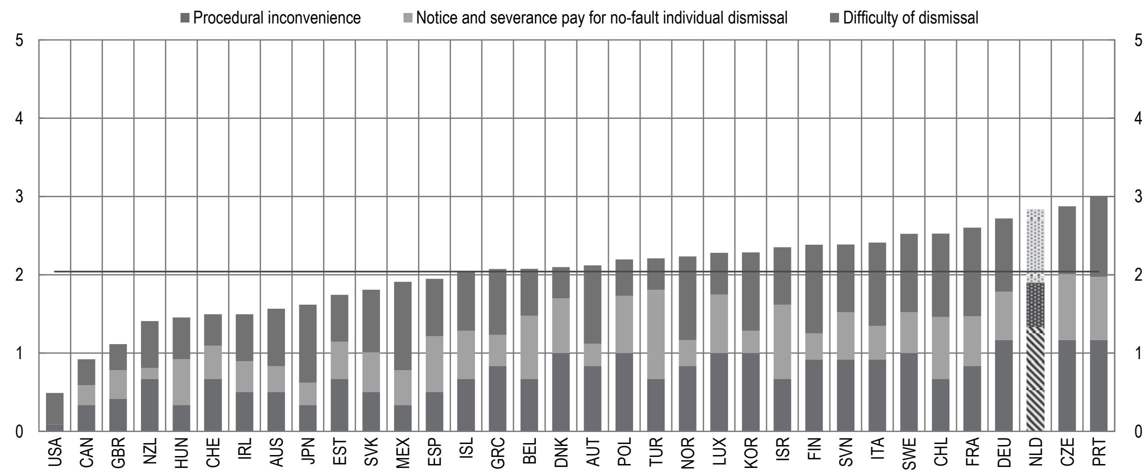
Source: Koske, I. Wanner, R. Bitetti and O. Barbiero (2014), "The 2013 Update of the OECD Product Market Regulation Indicators: Policy Insights for OECD and non-OECD Countries", *OECD Economics Department Working Papers*, forthcoming; and OECD (2014), *Economic Survey of the Netherlands*, OECD Publishing.

According to surveys on attitudes towards entrepreneurship, many in the Netherlands see entrepreneurship as a good career option. However, there are indications of a need for better acceptance of occasional failure. The low fraction of positive answers to the statement "Entrepreneurs who failed should have a second chance" puts the Netherlands towards the bottom of the list among OECD countries (OECD, 2013c). To help improve entrepreneurial attitudes and, in particular, further promote entrepreneurship among students, the government has recently scaled up ongoing efforts, following earlier initiatives in Finland, Denmark and Norway. There are already signs of success in this area. The Netherlands is, e.g., one of the highest scoring countries in Enrepreneurship Education in the Global Entrepreneurship Monitor (Xavier et al. 2013).

Labour market regulations for permanent contracts are relatively restrictive (see above and also Figure 2.18), and figure just after the first-ranking "access to financing" – also mentioned in the *Global Competitiveness Report* (World Economic Forum, 2013) – as the most problematic factors for doing business (Figure 2.19), especially as regards hiring and firing practices and lack of flexibility in wage setting. It is too early to know to what extent the plans put forward by the government in the first half of 2013 and expected to come into force in 2015 will ease the situation (OECD, 2014). Lowering the strictness of employment protection legislation may be particularly helpful for grass-root innovation which requires experimentation. The risk of high downsizing costs should not deter expansion (OECD, 2013f; Bartelsman et al., 2010).

Figure 2.18. The strictness of employment protection legislation

Scale from 0 (least stringent) to 6 (most restrictive), 2013

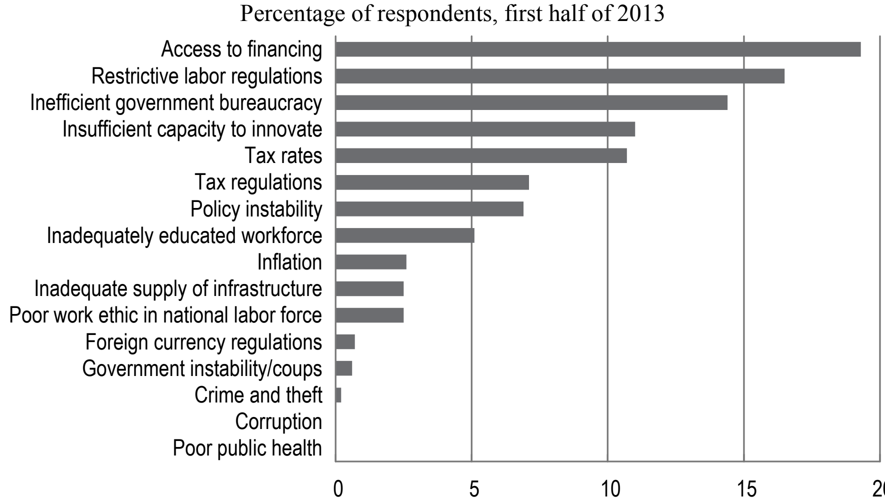


Note: The figure presents the contribution of different subcomponents of the indicator for employment protection for regular workers against individual dismissal (EPR). The EPR incorporates three aspects of protection: i) procedural inconveniences that employers face when starting the dismissal process, such as notification and consultation requirements; ii) notice periods and severance pay, which typically vary by tenure of the employee; and iii) difficulty of dismissal, as determined by the circumstances in which it is possible to dismiss workers, as well as the repercussions for the employer if a dismissal is found to be unfair (such as compensation and reinstatement). The height of the bar represents the value of the EPR indicator.

Source: OECD (2013), *OECD Employment Outlook 2013*, OECD Publishing, doi: 10.1787/empl_outlook-2013-en.

Figure 2.19. The most problematic factors for doing business

Percentage of respondents, first half of 2013



Note: From the list of factors above, respondents were asked to select the five most problematic for doing business in their country and to rank them between 1 (most problematic) and 5. The bars in the figure show the responses weighted according to their rankings.

Source: World Economic Forum (2013), *The Global Competitiveness Report 2013-14*, Geneva.

Box 2.2. The OECD product market indicator

A number of diagnostic tools have been developed to measure product market regulation and benchmark regulatory frameworks. One of these tools is the OECD product market indicators system. The OECD's PMR indicators assess the extent to which the regulatory environment promotes or inhibits competition in markets in which technology and market conditions make competition viable. These indicators have been used extensively over the last decade to benchmark regulatory frameworks in OECD and other countries and have proven useful in encouraging countries to implement structural reforms that enhance economic performance.

The PMR indicator system summarises a large number of formal rules and regulations with a bearing on competition. The regulatory data cover most of the important aspects of general regulatory practice as well as a range of features of industry-specific regulatory policy, particularly in the network sectors and more recently in the area of regulating the Internet economy. This regulatory information feeds into 18 low-level indicators that form the base of the PMR indicator system. These low-level indicators are then aggregated. At the top of the structure, the overall PMR indicator serves as a summary statistic on the general stance of product market regulation.

The PMR indicators have a number of characteristics that differentiate them from other indicators of the business environment. First, in principle, the low-level indicators only record "objective" information about rules and regulations, as opposed to "subjective" assessments of market participants as in the case of indicators based on opinion surveys. This isolates the indicators from context-specific assessments and makes them comparable across time and countries. Second, the PMR indicators follow a bottom-up approach, in which indicator values can be related to specific underlying policies. One of the advantages of this system is that the values of higher-level indicators can be traced with an increasing degree of detail to the values of the more disaggregated indicators and, eventually, to specific data points in the regulation database. This is not possible with indicator systems based on opinion surveys, which can identify perceived areas of policy weakness, but are less able to relate these to specific policy settings.

Source: Wölfl et al. (2009), "Ten Years of Product Market Reform in OECD Countries: Insights from a Revised PMR Indicator", *OECD Economics Department Working Papers*, No. 695, OECD Publishing, doi: 10.1787/224255001640 and Koske et al. (2014), "The 2013 Update of the OECD Product Market Regulation Indicators: Policy Insights for OECD and non-OECD Countries", *OECD Economics Department Working Papers*, forthcoming.

The labour market is characterised by a small flexible segment (often younger workers on temporary contracts or self-employed) and a large, more rigid segment (often older and better skilled workers with strong social protection) (OECD, 2012). This divide (or "duality") should be reduced. The flexibility of the labour market affects the agility of the innovation system by allowing a timely and smooth reallocation of workers from less successful to innovative and rising sectors and activities (OECD, 2013f).

Some policies have the highest impact at the top end of more productive firms (certain types of dedicated innovation policies), while others facilitate exit of the least productive units (e.g. bankruptcy laws) to free up resources to be used in more productive units. This reallocation of resources towards the most productive units also enhances aggregate productivity, and policies may hinder or facilitate this process. Results by Andrews and Criscuolo (2013) using a cross-country firm level database of inputs, outputs and patenting suggest that the Netherlands is less successful than the Nordic countries and the United States in attracting resources to innovative (i.e. patenting) firms.

Studies focused on the Netherlands – including Kocsis et al. (2009) and Anthony et al. (2012) – conclude that entry and exit barriers are probably not important impediments to growth, in line with the findings, presented above, that the time required in the Netherlands to open and close a business is one of the shortest. Brouwer and van der Wiel (2010) find that competition has both a direct and indirect effect – through innovation – on productivity. They emphasise that for most industries, the Netherlands is far from the very high intensity of competition that would be detrimental to innovation via the inverted U-shape effect (Aghion et al., 2005).

Finance

Financial conditions affect the ability of firms to obtain the resources they require. This is especially true for young and small businesses, which tend to be more constrained by a lack of available internal funding or collateral. Some of these businesses play an important role as a source of innovative business models and radical innovations (Henderson and Clark, 1990; Henderson, 1993; Andrews and Criscuolo, 2013). Once successful on a small scale, they need well-functioning financial markets to help them grow and expand the scale and scope of their innovation activities. An environment in which it is easier for successful firms to upscale also creates better opportunities to experiment with new solutions and to innovate.

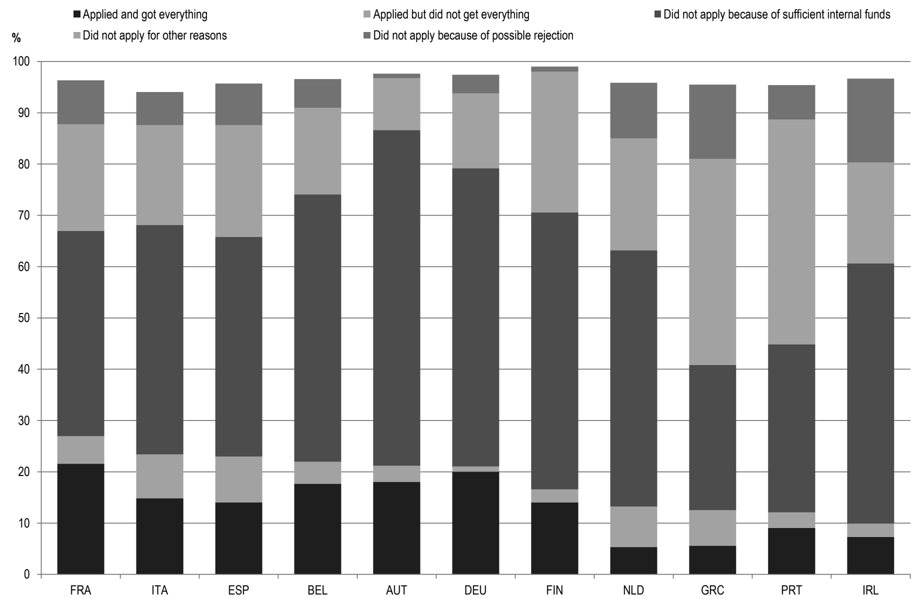
General financial conditions

Several sources indicate that credit conditions have been tight for SMEs since the beginning of the financial crisis. The SME lending survey of the European Central Bank shows that Dutch SMEs, anticipating possible rejection, are less likely to apply for credit than firms in Austria, Belgium, Finland and Germany (Figure 2.20). If they do apply, they are less likely to get what they wish. Drawing on the same source, Darvas (2013) notes that despite similar levels of profitability in the Netherlands and these other euro area countries, Dutch firms seem to have difficulties rather like those faced by the more troubled southern euro zone economies. The World Economic Forum (2013) ranks the Netherlands relatively low in terms of ease of access to credit. According to a survey of the Dutch National Bank (De Nederlandsche Bank, DNB) on the evolution of bank lending conditions (Figure 2.21*)*, credit standards for SMEs tightened again through 2013 after easing in the previous two years. Moreover, interest rate differentials between SME loans and other loans have increased substantially since the crisis and barely decreased up to 2012, possibly reflecting a still high risk premium attached to small business lending.[16]

To compensate for the current weakness of the banking sector in providing funds especially to SMEs, the government has set up various schemes to help them obtain credit (Ministry of Economic Affairs, 2013a; OECD, 2013e). Microfinance by Qredits reaches companies which are unable to obtain bank credit (outstanding amount: EUR 35 million); MKB credits (Borgstelling MKB-krediten) provide guarantees for bank loans to SMEs with little collateral (outstanding amount: EUR 2.4 billion); the GO (Garantie Ondernemingsfinanciering) provides primarily SMEs with guarantees for larger bank loans (outstanding amount: EUR 679 million); the Seed Facility supports private equity firms investing in early stage start-up companies (about EUR 135 million outstanding); and finally, the innovation credit is aimed at R&D projects (with roughly EUR 100 million outstanding). These instruments help to fill in the gap due to low levels of lending by financial institutions, but their size may still be insufficient fully to offset the negative impacts.[17] Restructuring bank's balance sheets is essential for expansion of their lending to SMEs in the medium term (OECD, 2014).

Figure 2.20. Bank lending constraints for SMEs

Answers to the question "Did your company apply for a bank loan in the last 6 months?"

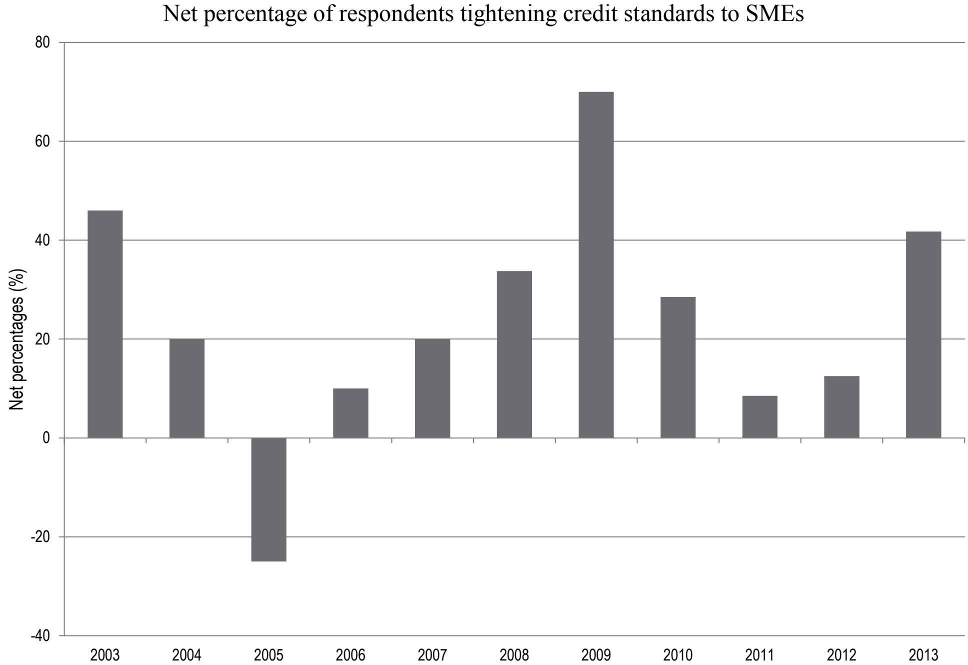


Note: SMEs are defined as firms with 0-249 employees.

Source: ECB (April-September 2013).

Figure 2.21. Tightening bank lending conditions to SMEs

Net percentage of respondents tightening credit standards to SMEs



Note: The net percentage shows the ratio of banks tightening their credit terms and conditions to banks easing them; the values may vary between -100% (where all banks ease their terms and conditions to a greater or lesser extent) and +100% (where all banks tighten their terms and conditions somewhat or considerably).

Source: De Nederlandsche Bank, Domestic MFI Statistics (2013), changes in credit standards and in demand for loans or credit with MFIs in the Netherlands.

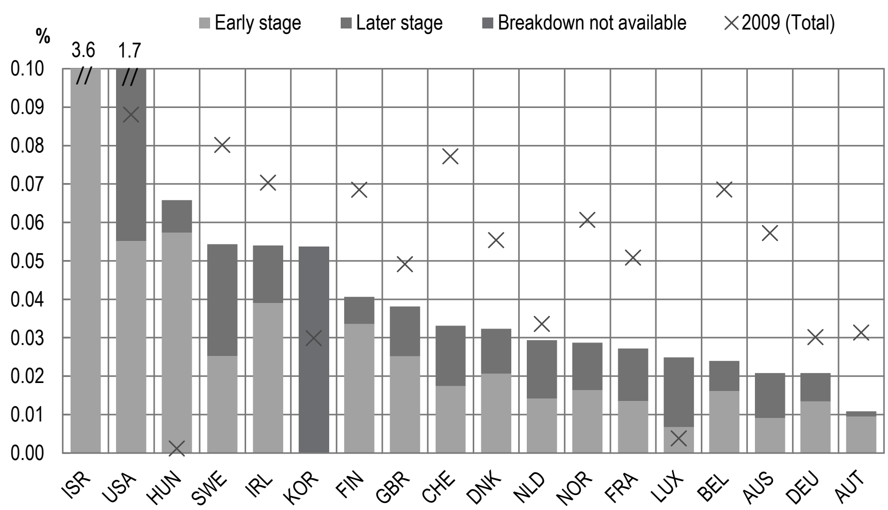
Risk financing

Evidence of the availability of early stage risk finance in the Netherlands is mixed. In particular, a recent OECD study highlighted the presence of restrictions on banks, pension funds and insurance companies when investing in private equity funds (Silva and Wilson, 2013). This may negatively affect the pool of financial resources and may be at least partially responsible for the small size of the venture capital market, especially the seed and early stages (Veugelers, 2011).

To address this shortcoming, the government has put in place several targeted financing facilities (fund of funds, regional development agencies, the growth facility), and is planning additional ones such as the early-stage instrument and the business angels co-investment facility. The fund of funds and co-investment approaches are considered good practice owing to their reliance on private investors' expertise, incentives and resources. Involving business angels is also a welcome step, and taken together, these facilities have the potential to improve substantially the venture capital investment climate (Figure 2.22).

Figure 2.22. Venture capital investment

As a share of GDP, 2012



Source: OECD (2011, 2013), *Entrepreneurship at a Glance*, using data from EVCA (Europe), NVCA (USA), KVCA (Korea), PwCMoneyTree (Israel).

ICT and transport infrastructure

The Netherlands has a highly developed technological and communications infrastructure, which dates back to the creation of the inter-university network Surfnet. It has one of the highest penetration rates among OECD countries for consumers as well as businesses (OECD, 2013b). Nearly all businesses, irrespective of size, have access to a broadband connection, either fixed line or mobile.

More recent wireless technologies are, however, less pervasive than on average in OECD countries (OECD, 2013b). Furthermore, the prices for subscriptions tend to be somewhat high, generally in the middle or in the upper ranking of OECD countries. This concerns mainly the mobile and wireless market, but also the broadband segment for bundles with high data volume and the fastest connection speeds. For instance, the monthly fee of a wireless broadband basket with 5 gigabytes of traffic was around

USD 27 (measured at PPP) compared to around USD 10 in Denmark, Finland and the United Kingdom. This may suggest that competitive pressures on the telecom and Internet service provider market are not strong enough. The potential entry of a fourth player to the mobile market may have a positive impact in this respect. The current regulatory environment is generally supportive of competition. In particular, the Netherlands, like Chile and Slovenia, requires "network neutrality" by law in order to stimulate competition among Internet service providers.[18]

The Netherlands owes much of its economic success to its highly developed water, rail and air transport infrastructure. Sea ports play an outstanding role, with Rotterdam as Europe's main port and a gateway to large parts of continental Europe, including Germany and the United Kingdom (OECD, 2012). They are considered to represent "best practices" as regards port performance and efficiency, reflected in aspects such as port planning, land organisation, environmental and climate management, and port communication (Merk and Notteboom, 2013). As such, they can effectively help sustain the high levels and further growth of re-exports and transit trade activities. The country has as well very high road and rail density, which suits its relatively dispersed economic activity, with several important, medium-sized cities and their agglomerations (OECD, 2013d). Schiphol is one of the largest airports in Europe and a hub of economic activity for the surrounding region.

2.4. The role of innovation in future development

Productivity can be seen as the main driver of economic development in the long term, and the major source of differences across countries in GDP per capita (OECD, 2013a; Figure 2.3). As labour market participation has a natural limit, the only source of sustained economic growth is gains in labour productivity. This is especially relevant for developed countries such as the Netherlands, where demographic changes are expected to constrain labour market participation in the years to come. Labour productivity, in turn, is driven by capital intensity and multifactor productivity, i.e. the joint efficiency of the production inputs, labour and capital. The broad picture emerging from the empirical literature is that it is MFP and not capital intensity that is the more important factor in shaping cross-country income differences (Hall and Jones, 1999; for recent empirical work, see Inklaar and Timmer, 2009, and Johansson et al., 2013).

For the most developed countries, innovation is typically the main driver behind increases in the overall efficiency of production inputs (as measured by MFP growth). An advanced country's long-run economic performance thus relies significantly on the level and quality of its innovation activities, i.e. the ability to generate, transfer and assimilate technological, non-technological, managerial, organisational and institutional innovations. Innovation can make an important contribution to some of the issues identified in this chapter in several ways:

- It can help to increase labour productivity, which has grown more slowly in the Netherlands than in other OECD countries for some time. A boost in labour productivity helps to contain unit labour costs and therefore to strengthen the international competitiveness of Dutch businesses.
- It can also help to improve the quality of products, allow firms to move their output up the quality ladder, or introduce radically new products and services. An upgraded export bundle can also help extend the reach of Dutch exports and benefit more from globalisation and the rise of emerging economies.

The prosperity of countries such as the Netherlands, which are at or near the technological frontier, hinges on maintaining a continuing flow of innovation (Aghion and Howitt, 2005), based both on knowledge and technology absorbed from abroad and to a lesser extent – given the size of the Netherlands – developed at home. Of course, continuously adopting existing best practices and adapting them to the local environment is necessary, but to preserve a top international position, the Netherlands has to engage in new-to-the-world innovation. It is in many ways well equipped to face the challenges ahead. The country not only has a great and long-standing tradition of excellence in science and technology, its science base still excels on many counts and in many areas. It has, and needs to maintain, a high level of absorptive capacity to monitor, screen and adopt advances in science and technology achieved abroad. The innovative performance of the Netherlands is generally regarded as good, although there is scope for improvement, as discussed in this review. These will require stronger investment in R&D and innovation, notably by the business sector, but also excellent framework conditions and well-functioning innovation system that ensures high returns to these knowledge-based investments.

Notes

1. Depending on the specification of the measures used, the role of different categories of labour (according to skill levels) and of capital (ICT and non-ICT capital) can be assessed separately (Hulten, 2001; OECD, 2001; Pilat and Schreyer, 2002).

2. One of the main determinants of productivity growth is the distance from the frontier, also known as the catch-up hypothesis (see Gerschenkron, 1962, for the original idea, and Acemoglu et al., 2006, for a more recent approach). As a country approaches the most efficient level attainable, further productivity improvements are increasingly hard to achieve.

3. A high productivity level is also captured by the measure of MFP (Johansson et al., 2013). Since measurement of MFP requires more assumptions and more detailed data than labour productivity, some of the results below are based on the latter.

4. Comparisons of productivity at the industry level raise significant measurement challenges. Industry outputs and value added should be converted to a common currency and account for the differences in local price levels, as is done through PPPs for aggregate comparisons. Constructing industry-level PPPs that are suitable for this purpose requires various assumptions and detailed price-level information (See Timmer et al., 2007; and Inklaar and Timmer, 2008).

5. Van Ark et al. (2013) analyse the evolution of MFP growth in the Netherlands and other European countries in great detail. In contrast to the methodology used by the OECD, they control for labour composition and the role of ICT capital.

6. Van Ark et al. (2013) present growth projections for the Netherlands and other EU countries. They forecast moderate MFP growth up to 2025; this compares quite well to other advanced EU countries.

7. To arrive at a better understanding of the drivers of aggregate and industry-level productivity developments, some recent studies focus on the firm level. They document great heterogeneity in productivity across businesses, even within narrowly defined industries (see Bartelsman and Doms, 2000, and Syverson, 2012, for an overview of the literature, and Andrews and Cingano, 2012, and Gal, 2013, for recent results). However, comparing firm-level outcomes across countries is made difficult by barriers to accessing national micro data. A rigorous cross-country comparison of firm-level productivity development using a *distributed micro-data approach* which avoids confidentiality problems is currently conducted at the OECD. The Netherlands participates in this project.

8. Recent OECD projections of labour market participation in the Netherlands predict a decline from the current 65% to 63% by 2030 and to 60% by 2060 (Johansson et al., 2013, Figure 6). This is a significant drop but still leaves the country with one of highest rates among OECD countries.

9. This declining tendency in the share of total economy value added in nominal terms is due to a combination of developments in relative prices, productivity and the share of production inputs (employment and capital) used in manufacturing. Further analysis

reveals that both declining employment shares and slowing MFP (see Table 2.1) contributed to the decline.

10. Re-exports are imported goods that leave the country with little further processing.

11. Statistics Netherlands (2011) notes that "…the top 1% of Dutch traders generated almost 74% of Dutch imports and 71% of exports" in 2008.

12. The revealed comparative advantage index is an industry-level measure of trade specialisation. Industries with a larger weight in total exports in the country than the weight they have in total world trade have a value larger than one.

13. It has to be noted however that high price is not always indicative of a "quality premium" but may reflect to market imperfections and inefficiencies.

14. The low share of exports in the high-price segment within that industry may partly be due to re-exports of natural resources (e.g. in coke, refined petroleum).

15. Hausmann and Hidalgo (2013) note that there is much to be gained from such a change. Their so-called Opportunity Value Index summarises the value of the option of being able to move easily towards export categories with higher complexity. It is based on the probability of jointly exporting any pair of goods – as an indication of differences in the knowledge content of goods – and on the current export structure of countries.

16. "SME loans" are defined by the DNB and the OECD's 2013 SME Scoreboard as loans of up to EUR 1 million.

17. According to OECD estimates, based on data from the domestic MFI statistics of De Nederlandsche Bank (2013), new SME loans from financial institutions amount to some EUR 15-20 billion a year. Support programmes such as the innovation credit, the Seed Facility, the SME loan guarantee scheme (BMKB) and Microfinance by Qredits may amount to approximately EUR 0.7-1 billion of investment support annually (Ministry of Economic Affairs of the Netherlands, 2013b; OECD, 2014).

18. Network neutrality requires Internet service providers (ISPs) to treat all users, data, content, platform, etc., equally and to avoid discrimination, i.e. preferable treatment of some services to allow for more traffic but reduce accessibility to other services, typically those that pose a competitive threat to the ISP's existing services.

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Chapter 3

Innovation performance in the Netherlands

This chapter reviews aggregate innovation performance in the Netherlands relative to other OECD countries, especially those with advanced innovation systems. It begins with an examination of the levels and flows of expenditure across institutional sectors (business, higher education and government) and of human resources for innovation. It then examines a number of indicators of innovation output (drawn from bibliometrics, patents and trademarks) and uses them to ascertain some salient qualitative characteristics of the Dutch innovation system.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

3.1. Innovation inputs

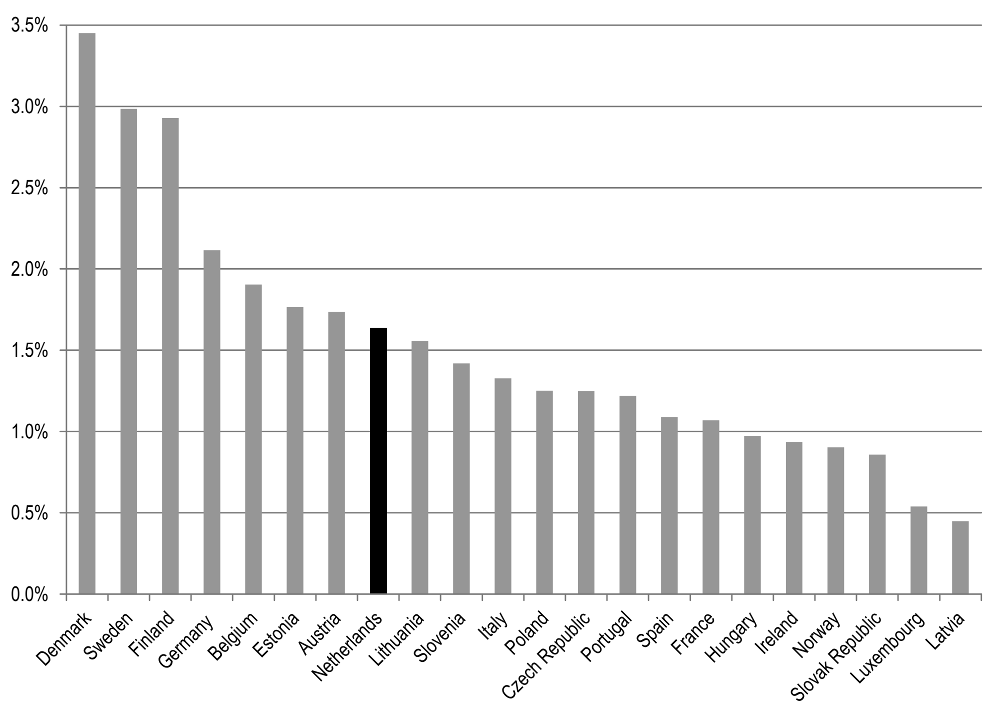
The ability to mobilise resources for innovation differs markedly across countries. In advanced innovation systems with good framework conditions, businesses find innovation profitable and devote considerable financial and human resources to it. In doing so they articulate social demands for innovation and leverage the system's innovation capabilities to meet them. Well-governed public research systems achieve social impact, recognition and trust, allowing governments to legitimise making substantial shares of their budgets available for research and innovation. A holistic assessment of the amount of financial and human resources devoted to innovation needs to take into account the diverse forms of innovation in various institutional sub-contexts. As a result various measures need to be employed.

Innovation and R&D expenditure

Systematically gathered aggregate indicators on innovation expenditure are not widely available. The EU's Community Innovation Survey (CIS) collects information on a broad range of innovation expenditures, not only for R&D, but also for acquisition of machinery, equipment and software and other external knowledge. The ratio of total innovation expenditure to firm turnover is a potentially revealing proxy of the prominence of innovation in firms' activities (Figure 3.1). The Netherlands is positioned at the upper end of countries considered, ahead of France and Norway but behind most other countries with advanced innovation systems.

Figure 3.1. Business innovation expenditure, 2008-10 CIS

Share of total firm turnover (irrespective of innovation)



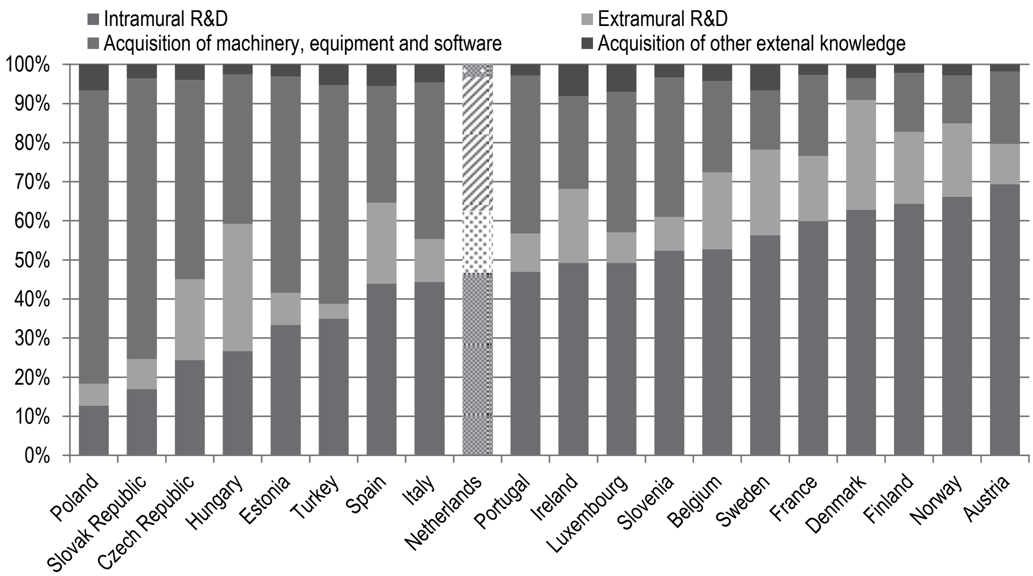
Note: International comparability may be limited as both sides of the fraction can be affected by the characteristics of national samples. For this reason more emphasis should be placed on the general position in the group than on the precise ratio values or country ranks.

Source: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Figure 3.2 shows a breakdown by type of expenditure, including intramural R&D, extramural R&D, acquisition of machinery, equipment and software and other external knowledge. Austria, Norway and Finland lead with respect to the share of innovation expenditure devoted to intramural R&D. The Netherlands' share of intramural R&D is smaller than that of the other advanced innovation systems. Its share of innovation expenditures in machinery, equipment and software is closer to that of Spain than to that of other advanced systems. This likely partly reflects the diversity of the Dutch economy and the prominence of the services sector relative to manufacturing.

Figure 3.2. Innovation expenditures by type

Percentage of total, 2010



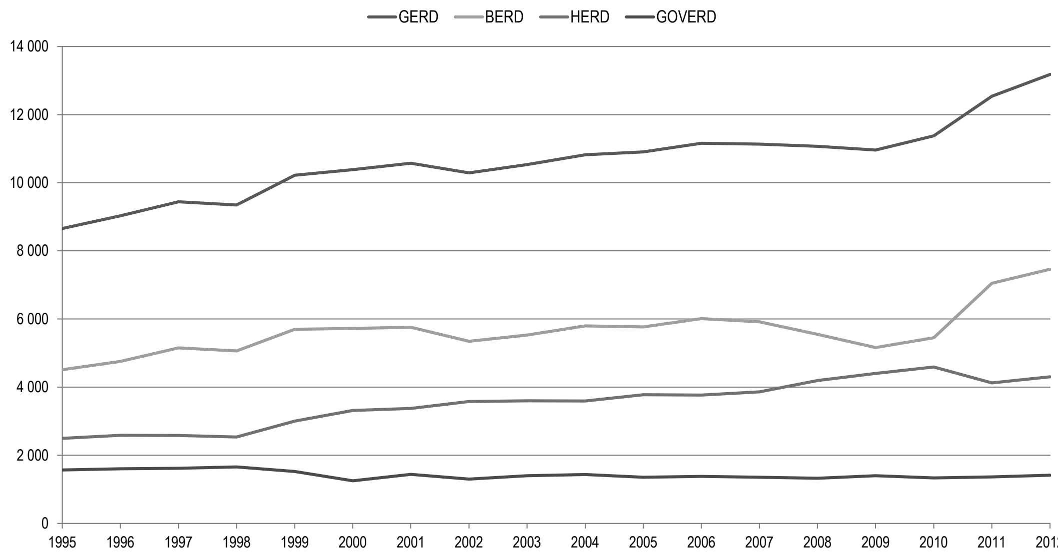
Source: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

In absolute terms, gross domestic expenditure on R&D (GERD) in 2011 totalled USD 14.6 billion (PPP, current prices). The Netherlands spends more on R&D than Belgium or Austria (about USD 10 billion each) and spends roughly the same order of magnitude as Sweden (USD 13.4 billion) (OECD, 2014a).

Real GERD has risen steadily from just over USD 8.6 billion (constant 2005 prices) in 1995 to USD 12.5 billion in 2011 (Figure 3.3), mainly owing to the increase in higher education expenditures on R&D (HERD). Government R&D expenditures display a steady trend since 1995. The sharp increase in business sector expenditure on R&D (BERD) in 2011 and the decline in HERD are mostly due to a break in series that complicates comparisons with previous years. This is because of changes aimed at improving the statistical measurement of R&D activity. According to Statistics Netherlands (2014) the changes included widening the definition of R&D conducted by companies[1], the inclusion for the first time of R&D spending by companies with fewer than ten persons employed and adjustments in the calculation basis for R&D spending in higher education[2]. According to Statistics Netherlands (2014) the changes in measurement resulted in an increase on BERD by 26%. This implies that over 80% of the increase in BERD in 2011 was due to changes in measurement.

Figure 3.3. Netherlands GERD and its components

Business, higher education and government expenditure on R&D, USD millions, constant 2005 prices PPP



Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

As in other advanced innovation systems, the business sector occupies a dominant position in funding research, accounting for 51%, against 34% for government institutions (Table 3.1). Business funds 82% of R&D performed by businesses (USD 6.7 billion PPP), 13% is funded from abroad and 4% by government. The business sector funds 8% of R&D performed by higher education, above the OECD average of around 6% (OECD, 2014a). Business also funds 17% of R&D performed by government, considerably above the OECD average of around 3-4%.

Table 3.1. GERD by sector of performance and source of funds, 2011

EUR millions (percentages of performance in italics)

Sector of performance	Business enterprise	Government	Higher education	Total (performance)
Source of funds				
Business enterprise	5 692	221	326	6 239
	82%	*17%*	*8%*	*51%*
Government	264	792	3 111	4 167
	4%	*60%*	*78%*	*34%*
Higher education	5	33	0	38
	0%	*3%*	*0%*	*0%*
Private non-profit	48	55	302	405
	1%	*4%*	*8%*	*3%*
Funds from abroad	913	218	255	1385
	13%	*17%*	*6%*	*11%*
Total (funding sector)	6 922	1 319	3 994	12 235
	100%	*100%*	*100%*	*100%*

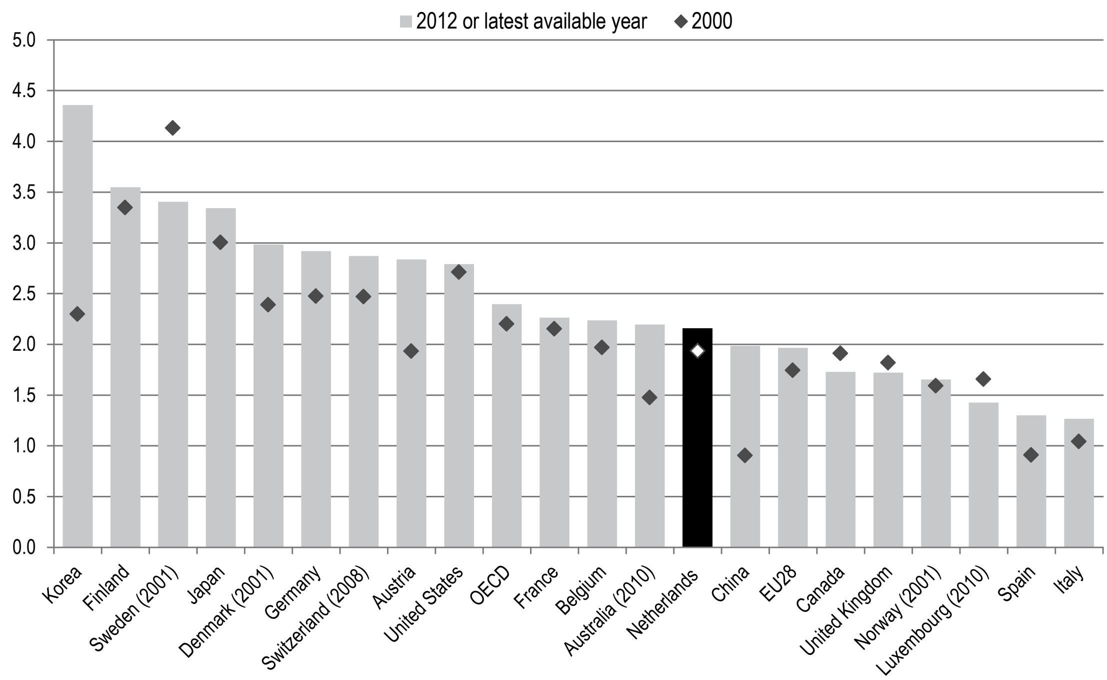
Note: These are revised figures for 2011 published in December 2013 by Statistics Netherlands which are not reflected in internationally comparable OECD statistics. The relative shares of funding and performance are in broad agreement with previously published figures, with the exception of the share of business funding in government performed R&D [11% according to figures in OECD (2014a)] and correspondingly the share of government funding in government performed R&D [71% according to figures in OECD (2014a)].

Source: Statistics Netherlands.

The Netherlands' GERD as share of GDP (commonly referred to as national R&D intensity) is quite stable (rising from 1.97% in 1995 to 2.16% in 2012) (Figure 3.4). The share is below the Lisbon Stategy EU objective of 3% and just above the EU27 average. R&D intensity in the Netherlands is significantly lower than in most other OECD countries with developed innovation systems, such as Korea (4.4%), Finland (3.6%), Sweden (3.4%) and Japan (3.3%). In the Netherlands, BERD intensity as well as HERD and GOVERD intensity have also been quite stable for a long time. GERD and particularly BERD increased in 2011, but this is mostly due to a change in the statistical measurement of research activities in enteprises (see discussion accompanying Figure 3.3 above).

Figure 3.4. Gross domestic expenditure on R&D

As a percentage of GDP, 2000 and 2012 or latest available year

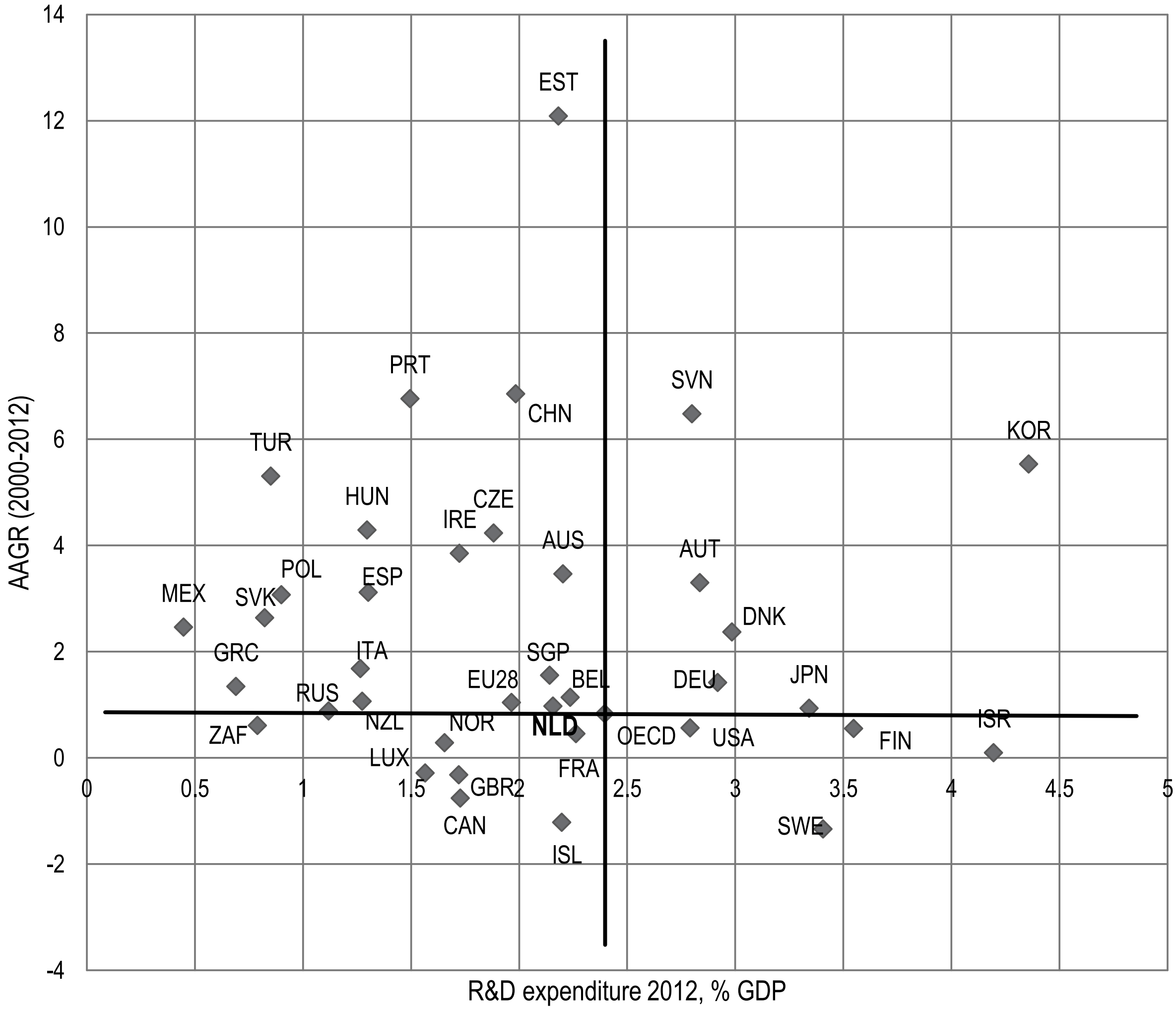


Note: 2012 figures are provisional except for Finland, Norway and Spain. Year of nearest available figures to 2012 or 2000 in brackets.

Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Figure 3.5 shows selected countries' R&D intensity on the horizontal axis and the corresponding average annual increase in R&D intensity over the period 2000-12 on the vertical axis. In 2012, the OECD average R&D intensity was 2.4%, and the OECD average annual increase in R&D intensity between 2000 and 2012 was 0.8%. The Netherlands lagged the OECD average for R&D intensity in 2012. After stagnation over most of the past decade and negative growth between 2007 and 2009, the country's R&D intensity has begun to rise since 2010. For 2000-12, the Netherlands' average annual rise in R&D intensity over 2000-12 stood at 0.9%, a figure that is however heavily influenced by the 2011 break in series.[3] In any case, the average annual increase in R&D intensity is below that of advanced systems such as Korea, Austria, Denmark and Germany.

Figure 3.5. R&D intensity, 2012 (or latest year available) and average annual growth rate of R&D intensity, 2000-12

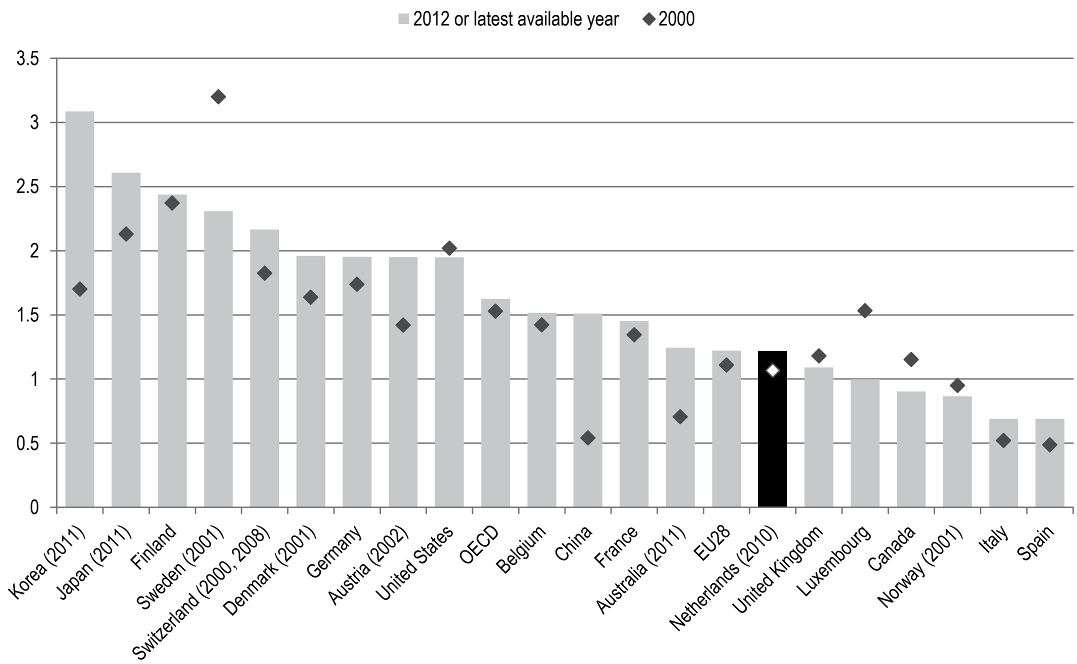


Source: OECD (2014a), *Main Science and Technology Indicatiors*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Figure 3.6 presents BERD intensity in the Netherlands and a selection of other countries. At 1.2%, the Netherlands' BERD intensity is below that of countries with advanced innovation systems such as Korea (3.1%), Japan (2.6%) and Sweden (2.3%), but also below the OECD average of 1.6%. BERD intensity in the Netherlands only increased from 1.06% in 2000 to 1.22% in 2012. Again, the increase is largely explained by a break in series in 2011.

Figure 3.6. Business expenditure on R&D

As a percentage of GDP, 2000 and 2012 or latest available year



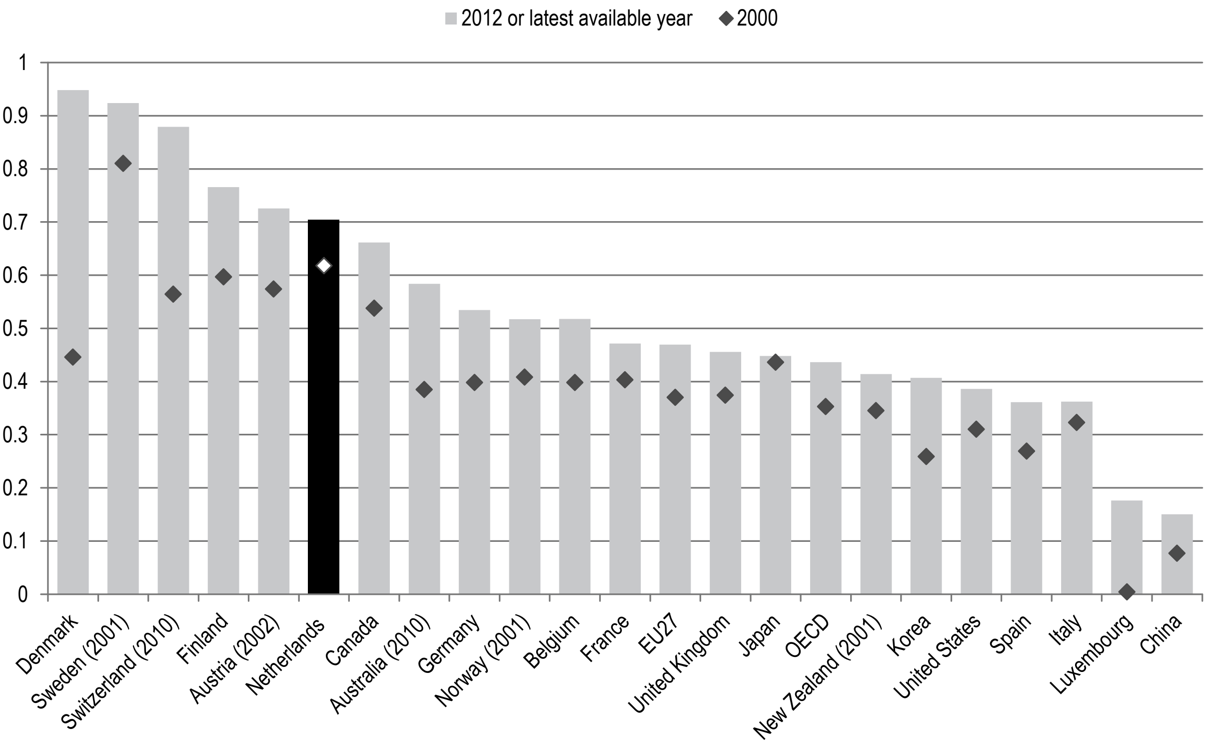
Note: 2012 figures are provisional except for Finland, China, Luxembourg, Norway, Spain and Switzerland.

Source: OECD (2014a), *Main Science and Technology Indicatiors*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Figure 3.7 displays HERD intensity. Like other advanced systems, the Netherlands (0.70%) has a HERD intensity above the OECD average (0.44%). Only Denmark (0.95%), Sweden (0.92%), Switzerland (0.88%), Finland (0.77%), and Austria (0.72%) have higher HERD intensities. As in most OECD countries, HERD intensity in the Netherlands increased since 2000 from 0.62%[4] to 0.70% in 2012. However, the increase was less pronounced than in other advanced systems, especially Denmark, but also Switzerland, Finland and Austria. The Netherlands' high HERD intensity has supported the strong position of its higher education institutions (HEIs) in international rankings, and their successful participation in European instruments.

Figure 3.7. HERD as a percentage of GDP in selected countries

2000 and 2012 or latest available year



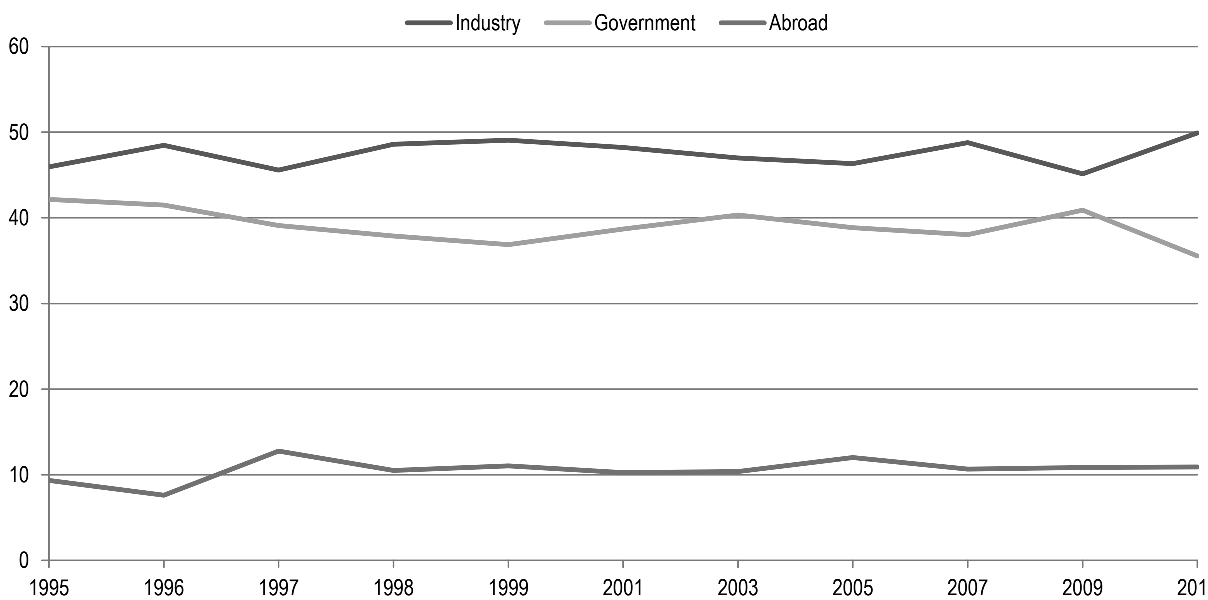
Note: The latest available year was 2011 for Japan, Korea, Luxembourg and New Zealand,. 2010 for Australia.

Source: OECD (2014a), *Main Science and Technology Indicatiors*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Looking at the evolution of R&D funding sources across time, the share of R&D financed by industry increased from around 46% of total R&D financing in 1995 to 50% in 2011 (Figure 3.8). The share of government financing decreased over the period from 42% to approximately 35%. The share of GERD funded from abroad has been stable around 10%. Despite the increases, compared to other countries with advanced innovation systems, the Netherlands still has a relatively small share of business R&D funding (50%), below both the EU28 (54%) and the OECD average (59%) and significantly behind countries such as Japan, Korea, Finland, Germany or Denmark (Figure 3.9).

Figure 3.8. Share of gross domestic expenditure on R&D financing by sectors

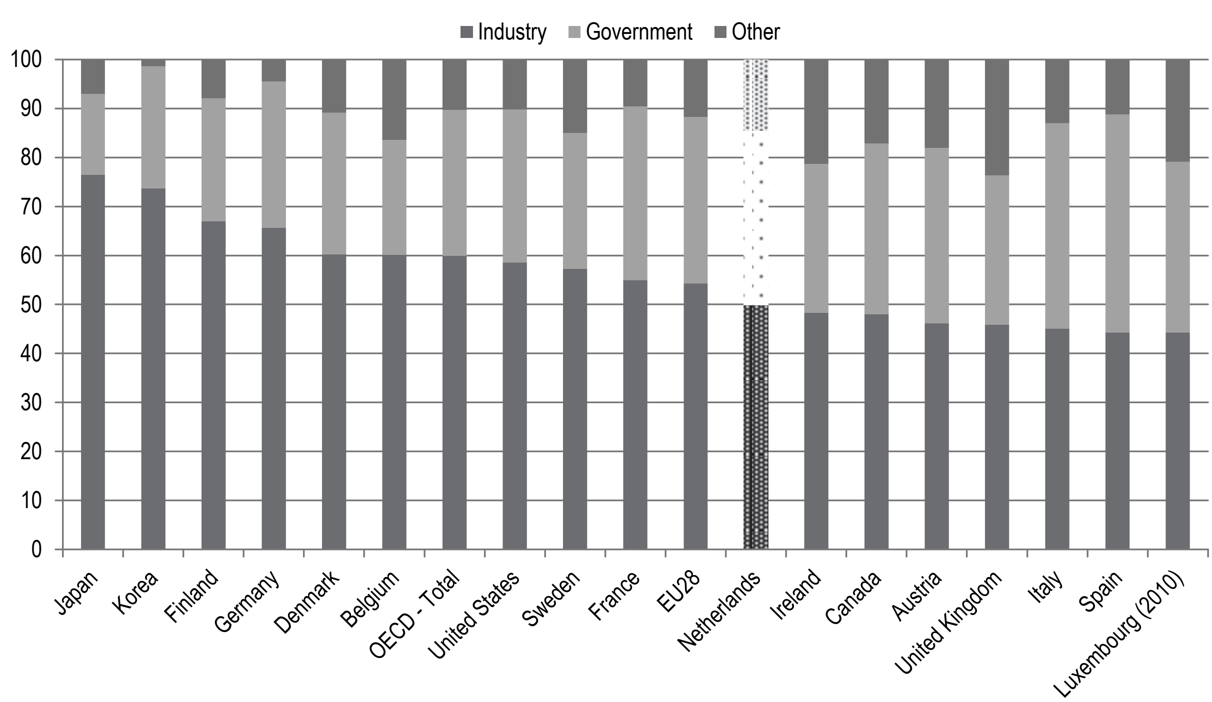
Percentage



Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Figure 3.9. Gross domestic expenditure on R&D by source of funding, selected countries

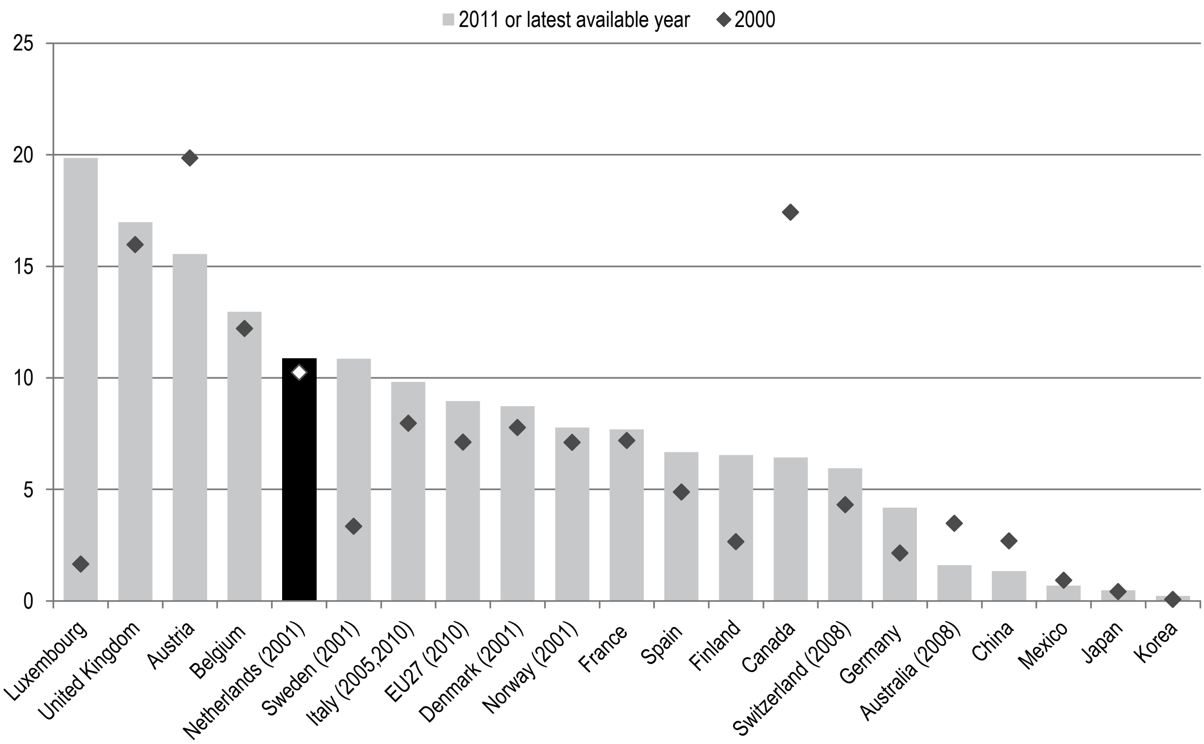
Percentage, 2011 or latest available year



Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

The share of GERD financed from abroad is relatively high in the Netherlands (in 2011 around 11%) and has been relatively stable (10.2 % in 1995) (Figure 3.10). The Netherlands is at the same level as Sweden (11), but below the levels of the United Kingdom (17%), Austria (16%) and Belgium (13%).

Figure 3.10. Percentage of GERD financed from abroad in selected countries



Source: OECD (2014a), *Main Science and Technology Indicatiors*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Human resources for science, technology and innovation

Human resources are the foundation of knowledge-based economies and thus a key issue for innovation policy. The many ways in which human resources relate to innovation are described in Box 3.1, which lists the wide array of knowledge and skills beyond science and engineering that are relevant for innovation. There are many ways individuals can build and accumulate human capital, such as education and training, work-place experience and international migration. The way countries leverage their human resources for research and innovation can often be improved.

Box 3.1. How do human resources spur innovation?

Generating new knowledge

Skilled people generate knowledge that can be used to create and introduce an innovation. Carlino and Hunt (2009) found that an educated workforce is the decisive factor in the inventive output of American cities; a 10% increase in the share of the workforce with at least a college degree raises quality-adjusted patenting per capita by about 10%. Data on Spanish regions also found a positive relationship between human capital and number of patent applications (Gumbau-Albert and Maudos, 2009). Lin (2009), using "new work" (i.e. new statistical occupational categories) as an indicator of innovation, found that locations with a high share of college graduates have more jobs requiring new combinations of activities or techniques. Such jobs appeared in the labour market along with application of new technologies and knowledge.

Adopting and adapting existing ideas

In many countries, incremental innovations involving modifications and improvements to existing products, processes and systems represent the bulk of innovation activity and can have great significance for productivity and the quality of goods or services. Higher skill levels raise economies' absorptive capacity and ability to perform incremental innovation by enabling people to understand how things work and how ideas or technologies can be improved or applied to other areas. Importantly, skills for adoption and adaptation are beneficial not just in R&D teams but across the wider workforce and population. Toner (2007) argued that the production workforce plays a strong role in incremental innovation when management encourages and acts on suggestions for improvement. Skills and absorptive capacity are also required in functions and activities such as marketing. For their part, skilled users and consumers of products and services can contribute to the adaptation of existing offerings by providing suppliers with ideas for improvement.

Enabling innovation through capacity to learn

Skilled people are better able to learn new skills, adapt to changing circumstances and do things differently. In the workplace, educated workers have a better set of tools and a more solid base for further "learning". This enhances their ability to contribute to innovation. Leiponen (2000) found that, in contrast to non-innovating firms, innovators' profitability was significantly influenced by the amount of higher education and higher technical and research skills possessed by employees.

Complementing other inputs to innovation

By interacting with other inputs to the innovation process, such as capital investment, people with better skills can spur innovation. Australian research has shown that human capital complements investment in information and communication technologies (ICTs), with the uptake and productive use of ICTs significantly influenced by management and employee skills (Gretton et al., 2004). A Canadian study found that a firm's human resource strategy, as well as its innovation strategy and business practices, influenced the extent to which it adopted new advanced technologies (Baldwin et al., 2004). Equally, a firm's lack of human capital is likely to exacerbate other constraints on innovation. Mohnen and Röller (2001) concluded that measures to remove barriers to innovation may be more effective if also explicitly directed at increasing levels of internal human capital.

Generating spillovers

Human capital can contribute indirectly to innovation through the "spillovers" generated by skilled people. Not only does skilled workers' knowledge diffuse throughout their workplace and the wider environment, they may also, through their interactions and their explicit or implicit actions as role models, spur accumulation of human capital by other workers. The resulting spread of ideas and upgrading of competencies can spur innovation. It has also been suggested that entrepreneurs "spill" knowledge by commercialising ideas that would otherwise not be pursued within the organisational structure of an existing firm (Acs *et al*., 2009).

…/…

Box 3.1. How do human resources spur innovation? *(continued)*

Contributing to social capital

Higher levels of human capital enhance social capital, and social capital can support innovation in several ways, predominantly through its effect on trust, shared norms and networking, which improve the efficiency and exchange of knowledge. Some studies suggest that higher levels of trust can promote venture capital financing of risky projects, owing to factors such as reduced monitoring costs (Akçomak and ter Weel, 2009). Closer relationships among actors can lead to the exchange of proprietary information and underpin more formal ties (Powell and Grodal, 2005), while social networks may also enable firms to work through problems and get feedback more easily, thereby increasing learning and the discovery of new combinations (Uzzi, 1997). Firms with higher levels of social capital are more likely to engage specialist knowledge providers, such as the public science base, to complement their internal innovation activities (Tether and Tajar, 2008). Social capital is also a feature of the "invisible colleges" that link researchers across geographic space in pursuit of common research interests.

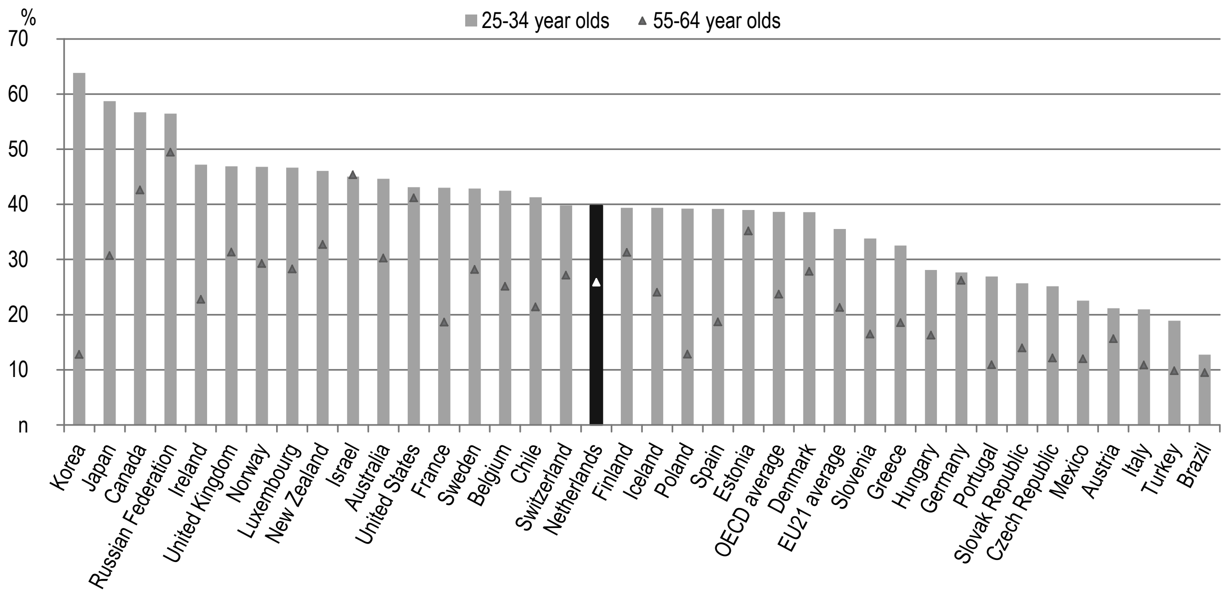
Source: OECD (2011), *Skills for Innovation and Research*, OECD Publishing, doi: 10.1787/9789264097490-en.

Education and training

In 2010, the Netherlands invested about 6% of GDP in education, a share equivalent to the OECD average. It spent USD 11 800 PPP per student in secondary education, close to USD 3 000 PPP more than the average OECD country (OECD, 2013a). The Netherlands spent about USD 17 200 PPP per student in tertiary education, around USD 3 600 PPP more than the average OECD country. The shares of private expenditures in tertiary education, however, amounted only to 28.2% whereas for OECD countries the average was 31.6%. This difference may reflect the fact that public tertiary education funding is sufficient, but may also reflect low private spending on adult education. Dutch private investments focus on primary, lower secondary and upper secondary education, with 13.1% of expenditures, while the OECD average is 8.5%.

Tertiary educational attainment can be used as a broad measure of a country's ability to accumulate human capital of potential relevance to innovation. In 2011, the Netherlands reported tertiary attainment rates of 32% in adults, matching the OECD average (32%) and exceeding that of the EU (29%). Figure 3.11 breaks down attainment rates between younger (25-34 years old) and older (55-64 years old) age groups. For the Netherlands, these levels correspond to 40% and 26% of the respective age groups. The Netherlands has a highly educated workforce overall, as its indicators match or exceed OECD and EU averages. The Netherlands surpasses Finland and Denmark in the young adult age group, but Norway and Sweden perform better in both age groups. At 72%, the share of the population 25-64 years of age having completed upper secondary education lags slightly behind the OECD and EU averages of 75% and 76%, respectively (OECD, 2013a). The relatively lower ranking of the older age group in the Netherlands is probably due to the fact that until a few years ago there were hardly any short-duration tertiary education programmes.

Figure 3.11. Percentage of the population with tertiary education by age group, 2011



Source: OECD (2013d), *Education at a Glance*, OECD Publishing, doi: 10.1787/eag-2013-en.

The Netherlands stands out as having one of the lowest percentages of young people not in employment, education or training (NEET) among all OECD countries. However, this proportion has risen significantly since the start of the global financial crisis. The 15-29 year olds with tertiary education have been particularly affected; the proportion of NEETs rose from 2% in 2008 to 5% in 2011 (OECD, 2013a). Nevertheless, this indicator remains well below the OECD average of 13% in 2011.

Dutch tertiary education institutions are producing more graduates (Table 3.2). In 2011, 38.9% of the 20-29 year age group participated, considerably above the EU27 average of 31.9%. Between 2006 and 2011 the average annual increase was also one of the highest at 5.7%. Tertiary students in science and engineering (S&E) fields account for 13.9% of students, around half of the EU27 average of 25.3%. The Netherlands is not closing this gap, as the growth rate in S&E is the same as that of EU27 (3.8%). The lag is particularly pronounced with respect to countries with advanced innovation systems, such as Austria, Sweden, Denmark and Germany, as well as Ireland. The lag is quite even in terms of the shares of tertiary students across broad subjects ("science, mathematics and computing" and "engineering, manufacturing and construction").

Table 3.2. Students participating in tertiary education, total and selected fields of study

Share of the population aged 20–29 and of all tertiary students, EU27 and selected countries, 2011

	All fields			S&E[1]			Science, mathematics and computing	Engineering, manufacturing and construction
	Total number in 1000s	As a % of population aged 20-29	AAGR 2006-11	As a % of population aged 20-29	As a % of all tertiary students	AAGR 2006-11	As a % of all tertiary students	As a % of all tertiary students
Austria	362	34.1	6.8	8.7	25.4	7.8	11.0	14.5
Belgium	462	33.6	2.9	5.3	15.6	2.1	5.2	10.4
Denmark	259	39.6	1.9	7.6	19.1	2.5	8.5	10.6
Germany	2 763	28.1	3.4	9.0	32.1	4.2	14.3	17.8
Hungary	382	29.4	-2.2	6.5	22.1	1.4	7.2	14.9
Ireland	196	29.9	1.0	7.8	26.2	3.5	14.4	11.8
Italy	1 968	29.9	-0.4	7.7	25.8	1.1	8.1	17.7
Netherlands	780	38.9	5.7	5.4	13.9	3.8	6.2	7.7
Norway	230	36.0	1.2	6.0	16.6	1.6	8.5	8.1
Poland	2 080	35.8	-0.3	7.8	21.9	1.4	8.0	14.0
Portugal	396	30.4	0.7	8.8	28.9	0.4	7.2	2.2
Spain	1 950	36.5	1.3	10.0	27.5	0.0	9.8	17.7
Sweden	464	37.8	1.4	9.8	25.9	1.5	9.2	16.7
Switzerland	258	26.0	4.3	6.1	23.6	3.8	9.8	13.8
United Kingdom	2 492	29.3	1.5	6.4	22.0	1.3	13.5	8.5
EU27	20 128	31.9	3.7	8.1	25.3	3.9	10.3	15.0

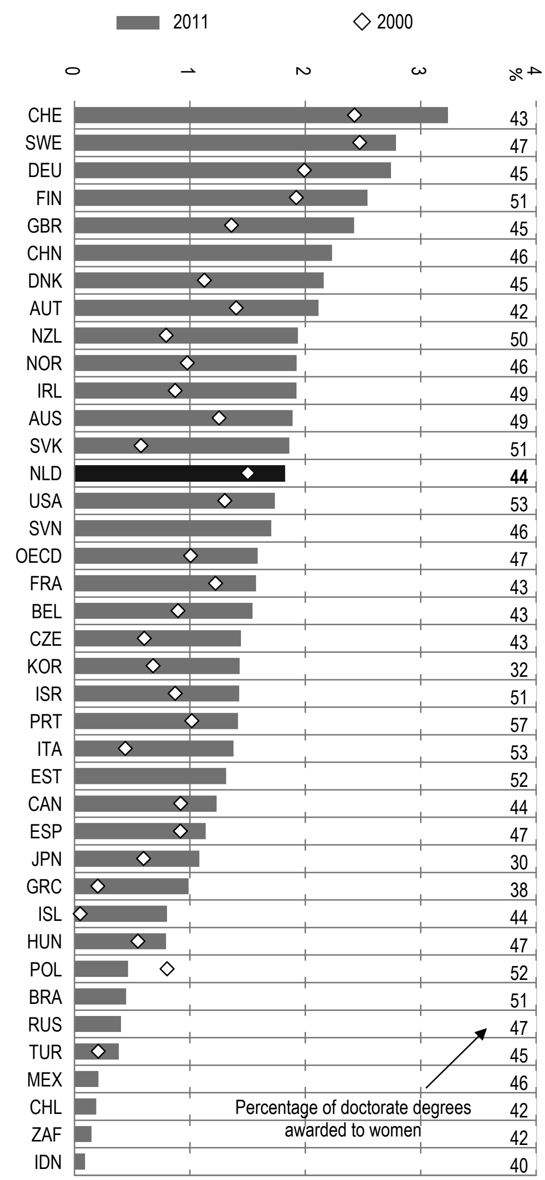
Note: 1. S&E = science, mathematics, computing + engineering, manufacturing and construction. AAGR = average annual growth rate.

Sources: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

The Netherlands produces fewer doctoral graduates than many other OECD countries (Figure 3.12). Still, at 1.8%, the share of doctoral graduates in the reference age cohort is above the OECD average (1.6%) and higher than the United States (1.7%), France (1.6%) and Belgium (1.5%). Between 2000 and 2011, the Dutch share of doctoral graduates grew by only 0.3 percentage points; growth was higher in Denmark (1%), the United Kingdom (1%) and Norway (0.9%).

Figure 3.12. Graduation rates at the doctoral level, 2000 and 2011

As a percentage of the population in the reference age cohort

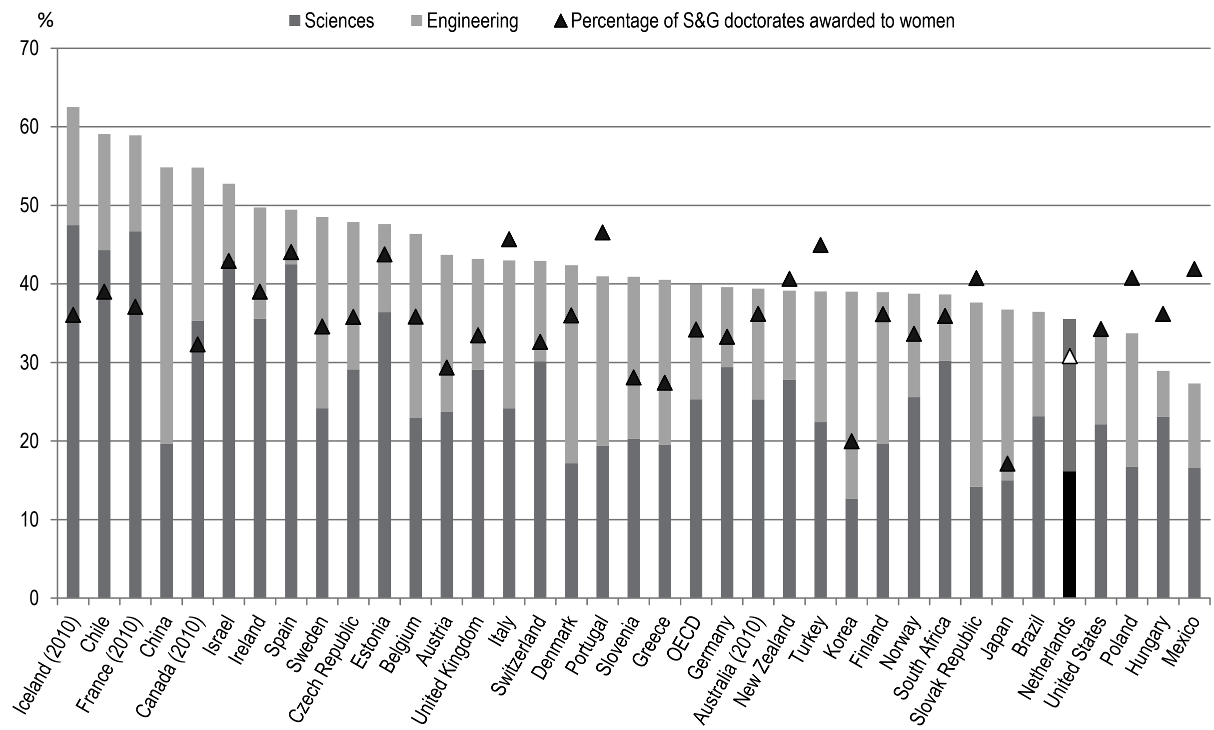


Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

In keeping with the pattern observed in Table 3.2 for general tertiary education, the share of S&E doctorates awarded in the Netherlands in 2011 (35%) is below the OECD average (40%). Figure 3.13 puts the Netherlands behind countries with advanced innovation systems such as Sweden (49%), Belgium (46%), Germany (40%) and Norway (39%). This is mainly due to the low share of doctoral degrees in science fields (16% in the Netherlands against the OECD average of 25%). At the same time, engineering graduates at the doctoral level (19%) surpass the OECD mean (15%) as well as the British (14%), Norwegian (13%) and German (10%) levels.

Figure 3.13. Science and engineering graduates at the doctoral level, 2011

As a percentage of all new degrees awarded at the doctoral level



Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en, p. 95.

The Programme for International Student Assessment (PISA) is a triennial international survey to assess education systems by testing the skills and knowledge of 15-year-old students. Table 3.3 shows countries' mean PISA scores for 2012 in mathematics, reading and science. In 2012, the Netherlands scored considerably higher than the OECD average in all three areas, i.e., mathematics: 523 against 494; reading: 511 against 496; and science: 522 against 501. These scores are suggestive of the high quality of the Dutch education system up to the secondary level and place it among the world leaders.

Table 3.3. Mean PISA scores, 2012

	Mathematics	Reading	Science
OECD average	**494**	**496**	**501**
Korea	554	536	538
Japan	536	538	547
Switzerland	531	509	515
Netherlands	523	511	522
Estonia	521	516	541
Finland	519	524	545
Canada	518	523	525
Poland	518	518	526
Belgium	515	509	505
Germany	514	508	524
Austria	506	490	506
Australia	504	512	521
Slovenia	501	481	514
Denmark	500	496	498
France	495	505	499
United Kingdom	494	499	514
Norway	489	504	495
Portugal	487	488	489
Italy	485	490	494
Spain	484	488	496
Russian Federation	482	475	486
Sweden	478	483	485
Romania	445	438	439
Thailand	427	441	444
Chile	423	441	445
Malaysia	421	398	420
Mexico	413	424	415
Uruguay	409	411	416
Costa Rica	407	441	429
Brazil	391	410	405
Argentina	388	396	406
Tunisia	388	404	398
Colombia	376	403	399
Indonesia	375	396	382
Peru	368	384	373

Legend (cell shading):
- Dark grey: Significantly above the average
- White: Not significantly different from the average
- Light grey: Significantly below the average

Source: OECD (2014b), *PISA 2012 Results: What Students Know and Can Do (Volume I, revised edition, February 2014): Student Performance in Mathematics, Reading and Science*, OECD Publishing, doi: 10.1787/9789264208780-en.

Table 3.4 contains three skill indicators for adult populations gathered by the OECD's Programme for the International Assessment of Adult Competencies (PIAAC). In particular, the table shows the 2012 mean proficiency scores of 16-65 year olds in literacy and numeracy, and the percentage of 16-65 year olds scoring at Level 2 or 3 in problem solving in technology-rich environments. Results in the Netherlands exceed by a wide margin the average of most participating countries. It is only outperformed by Finland in literacy and by Japan and Finland in numeracy. Its performance in problem solving in technology-rich environments is only surpassed by that of Sweden and matched by Finland. The Netherlands is one of the few countries, along with Norway and Sweden, to have less than 7% of the adult population lacking the basic skills needed to use ICTs. Around 16% of 25-64 year olds in the Netherlands participated in education and training in 2012 (Eurostat, 2014). Though this share is above the EU28 average of 9%, it is considerably smaller than the 30% share of the leaders, Denmark and Switzerland, and is also lower than that of Sweden, Finland and Norway.

Table 3.4. Summary of proficiency in key information-processing skills, 2012

Countries	Literacy (mean score)	Numeracy (mean score)	Problem solving in technology-rich environments (% at level 2 or 3)
OECD			
National entities			
Australia	280	268	38
Austria	269	275	32
Canada	273	265	37
Czech Republic	274	276	33
Denmark	271	278	39
Estonia	276	273	28
Finland	288	282	42
France	262	254	m
Germany	270	272	36
Ireland	267	256	25
Italy	250	247	m
Japan	296	288	35
Korea	273	263	30
Netherlands	**284**	**280**	**42**
Norway	278	278	41
Poland	267	260	19
Slovak Republic	274	276	26
Spain	252	246	m
Sweden	279	279	44
United States	270	253	31

Significantly above the average

Not significantly different from the average

Significantly below the average

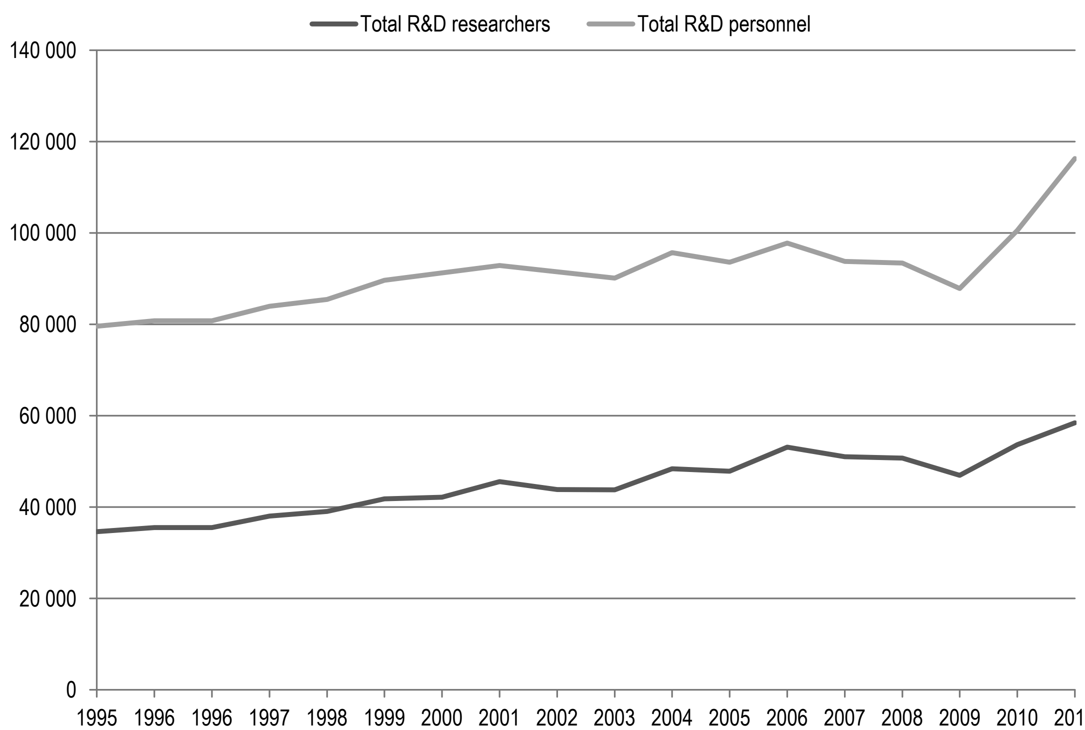
Source: OECD (2013c), *OECD Skills Outlook 2013: First Results from the Survey of Adult Skills*, OECD Publishing. doi: 10.1787/9789264204256-en.

R&D personnel

R&D personnel includes researchers and other support staff such as technicians and managers. The number of R&D personnel over time provides a perspective on the changing nature of countries' R&D activities. As a large portion of R&D investment goes to the salaries of research personnel, headcounts correlate strongly (albeit imperfectly) with GERD. Shifts in the relation between GERD and R&D personnel may indicate a change in policy focus, either towards the improvement of human resource capabilities or towards the development of infrastructures (e.g. laboratories and research centres). While the number of R&D personnel provides valuable information about the supply of human resources, it does not allow for evaluating the quality of their skills and how these are deployed.

Figure 3.14 shows that, with the exception of minor fluctuations in recent years, the number of R&D personnel and of researchers (full-time equivalent, FTE) has increased in the Netherlands over the last 15 years. R&D personnel rose from around 80 000 in 1995 to more than 116 000 in 2011. While a decline was observed between 2006 and 2009, growth seems to have resumed. The gap between the number of total R&D personnel and the total number of researchers was quite stable over 1995-2010 but widened considerably in 2011 owing to changes in the measurement of R&D activities in the business sector.[5]

Figure 3.14. R&D personnel and researchers (full-time equivalent) in the Netherlands, 1995-2011

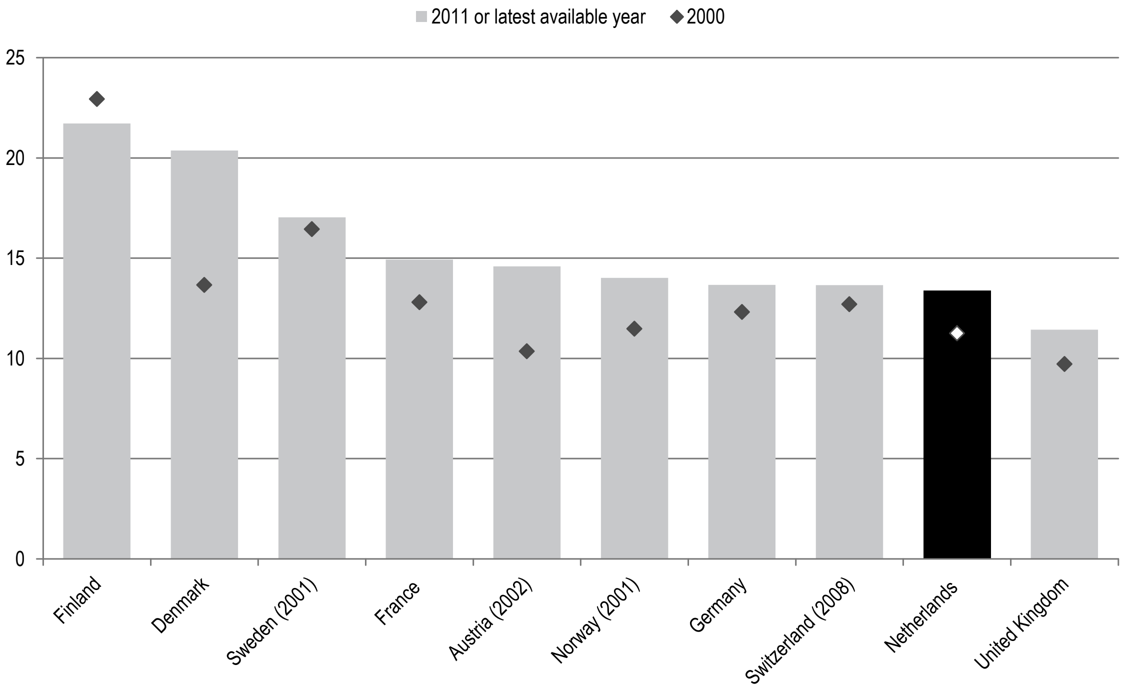


Note: A break in series occurred in 2011.

Source: OECD (2014a), *Main Science and Technology Indicatiors*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

In an international perspective, total R&D personnel (FTE) per thousand total employment in the Netherlands (13.4%) is on the lower end of the group of comparator countries with advanced innovation systems (Figure 3.15). Moreover, the Netherlands' 2.1 percentage point growth between 2000 and 2011 was weaker than in Austria (4.5%) and Denmark (6.5%).

Figure 3.15. Total R&D personnel (FTE) per thousand total employment in selected countries, 2000 and 2011



Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

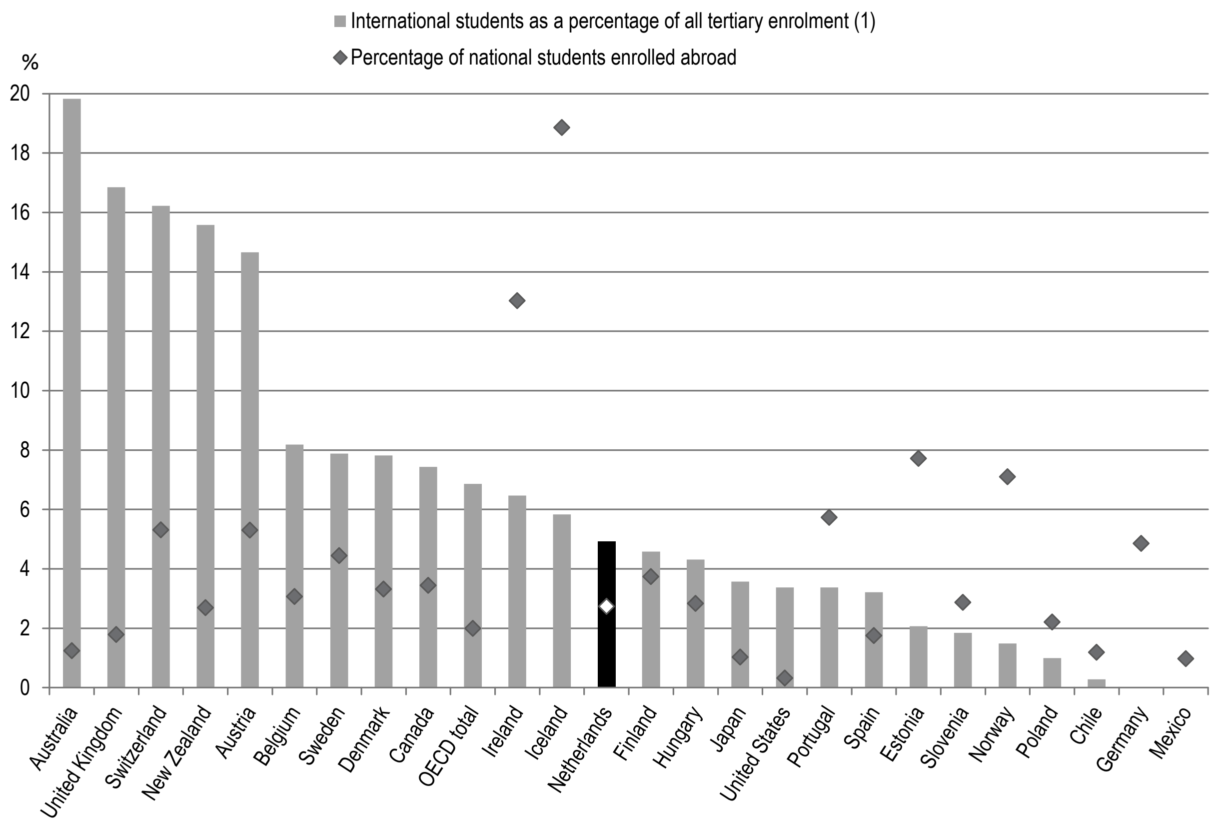
International migration of human resources for S&T and innovation

The migration of highly skilled human resources contributes to the creation and circulation of knowledge. Migrating individuals bring with them skills, knowledge and talent. Obtaining international experience can be important for many researchers and for their home systems, particularly if they return. Internationally mobile human resources can help research systems grow, improve knowledge flows and collaboration across countries, and lead to entrepreneurship and employment creation. Besides economic incentives, many other factors may contribute to the international migration of highly skilled people, such as a high-quality research infrastructure and opportunities to work with renowned scientists. In addition, language and quality of life also make certain countries more attractive for immigration than others (OECD, 2008).

The percentage of nationals enrolled abroad provides a view of outward mobility. Similarly, inward mobility can be proxied by the number of international students.[6] Figure 3.16 shows the performance of OECD countries on these two indicators for 2011. The Netherlands has 2.7% of its national students enrolled abroad, somewhat above the OECD average (2.0%). Conversely, at 4.9%, the country has a smaller share of international students among its tertiary education institutions than the OECD average (6.9%). In great part, this is due to the Dutch higher education's binary system, split between universities of applied sciences (UAS) and academic universities (WO). The latter are more likely to attract foreign students, while the former are large by international standards. In 2011, 44% of all international students in the Netherlands were enrolled in social science, business and law programmes (OECD, 2013b). Data from the

Association of Dutch Universities (VSNU) suggests that the share of foreign scientific personnel in universities has increased consistently in the past decade, from 20% in 2003 to 33% in 2012 (Rathenau Institute, 2013).

Figure 3.16. Mobility patterns of tertiary students, 2011



Note: 1. Data for Switzerland excludes tertiary-type B programmes.

Source: OECD (2013d), *Education at a Glance 2013: OECD Indicators*, OECD Publishing. doi: 10.1787/eag-2013-en.

The status of women in Dutch research

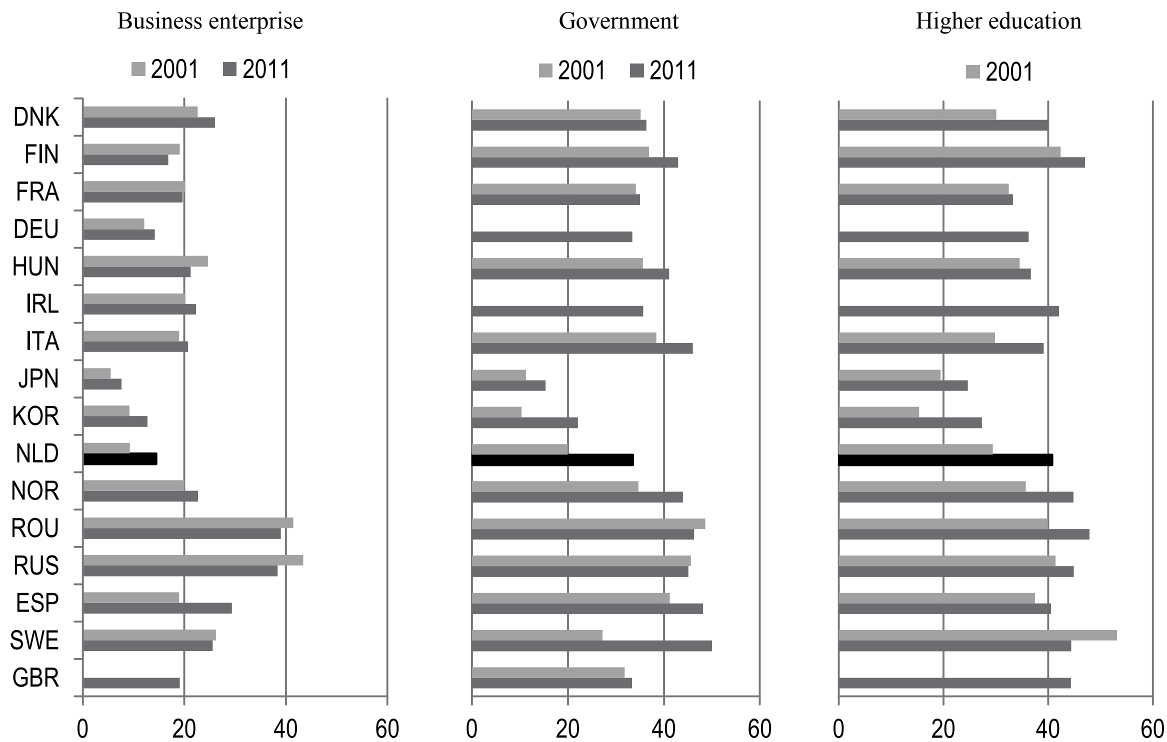
Even though women are the majority in the university student population, their share decreases progressively for higher qualifications and positions in universities' professional hierarchy. At the professor level, women have a smaller share in the Netherlands than in EU27, though their growth rate in 2002-10 was more rapid than in the EU27 (OCW, 2013). While progress has been made over the past decade, only 24% of researchers are women compared to over 35% in the United Kingdom, Norway and Sweden (OECD, 2014a).

With respect to research positions, most European countries are gradually closing the gender gap in research positions in higher education and the public sector (Figure 3.17). In Dutch higher education institutions, the share of women in research increased from 29% in 2001 to 41% in 2011. The Netherlands is thus approaching gender parity, but is still behind countries like Finland (47%), Norway and Sweden (45% each). The share of Dutch female researchers in government research institutes increased from 20% in 2001 to 34% in 2011. Despite this increase, recent shares lag behind countries such as Italy

(46%), Spain (48%) and Hungary (41%). All countries considered seem to have difficulties balancing male-female ratios in business-sector research positions. The Netherlands has made considerable progress from 9% in 2001 to 14% in 2011. Recent values remain, however, among the lowest and exceed only those of Korea (13%) and Japan (8%). In parallel to lower participation rates, there is a wage gap between male and female doctorate holders: the differential exceeds 20% in the business enterprise sector and the government sector (Auriol et al., 2013).

Figure 3.17. Female researchers by sector

Females as a percentage of total, 2001 and 2011

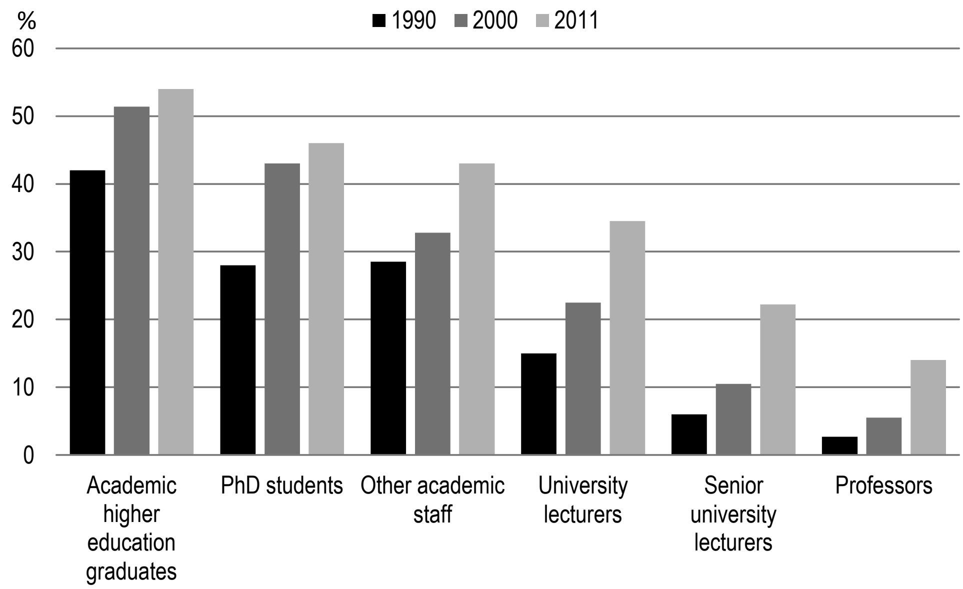


Source: OECD (2014a), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

Figure 3.12 shows that slightly fewer women obtain PhD degrees in the Netherlands (44%) than in the OECD area (47%). As is generally the case, Scandinavian countries have more evenly balanced gender parity in terms of the share of doctoral degrees awarded to women: Finland (51%), Sweden (47%) and Norway (46%). In all countries, women account for a lower share of S&E doctorates (Figure 3.13): on average across OECD countries, only 34% of S&E PhD graduates are female. The Netherlands had a somewhat lower share of 31%.

Figure 3.18 shows female participation at the different stages of academic careers between 1990 and 2011. As is generally the case, there is less gender parity higher up the hierarchical ladder. While women accounted for around 35% of university lecturer positions in 2011, they accounted for less than 15% of professors. However, the Netherlands has made significant progress during the last 20 years. At all stages shown in Figure 3.18, female participation has grown by 10 percentage points or more.

Figure 3.18. Female participation in academic careers, 1990-2011



Source: OCW (2013), "Key Figures 2008-2012 Education, Culture and Science", Ministry of Education, Culture and Science, www.government.nl/documents-and-publications/reports/2013/07/31/key-figures-2008-2012.html, p. 172.

3.2. Innovation outputs

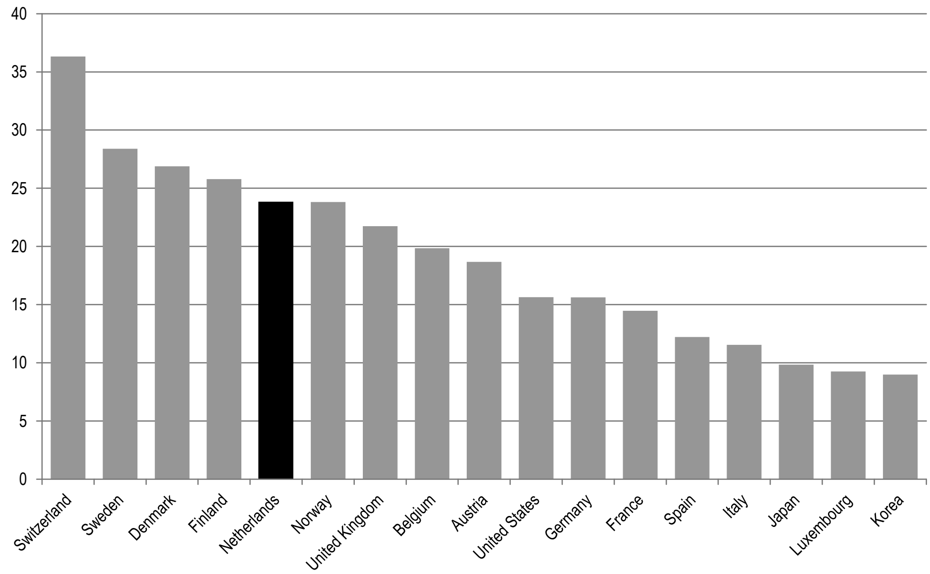
Innovation outputs are difficult to measure for a number of reasons. Available indicators only partially cover the various forms of innovation. Measures of technological innovation and scientific outputs are easily obtained and available. However, it is difficult to capture the level and qualities of process, organisational and marketing innovations, which are especially important for the services sector. In addition, with the exception of indicators derived from innovation surveys, traditionally used innovation output indicators are derived from data, such as patents and bibliometrics, originally collected for different purposes. Finally, as no two innovations are alike, the impact of innovations may differ greatly for every increment of measurement. Such limitations make the picture obtained from aggregate indicators inevitably partial and show the need for long temporal and country coverage as well as independent further validation. Nevertheless, taken together, the various available indicators of innovation present an opportunity to evaluate output systematically in a way that is consistent across countries and over time.

Scientific publications

The Netherlands is a leading OECD country in terms of the intensity of scientific output (Figure 3.19) and even more so in terms of visibility and impact (as measure by scientific citations, Figure 3.20). Over 2000-11, the Netherlands produced 23.9 scientific publication per million inhabitants, behind Switzerland (36.3), Sweden (28.4), Denmark (26.9) and Finland (25.8), but considerably ahead of other advanced systems such as the United Kingdom (21.7), the United States (15.6) and Germany (15.6). In terms of number of citations per published scientific article and of the share of publications among the top 10% cited, the Netherlands ranks second after Switzerland and before countries such as Sweden, the United Kingdom and Germany.

Figure 3.19. Intensity of scientific output

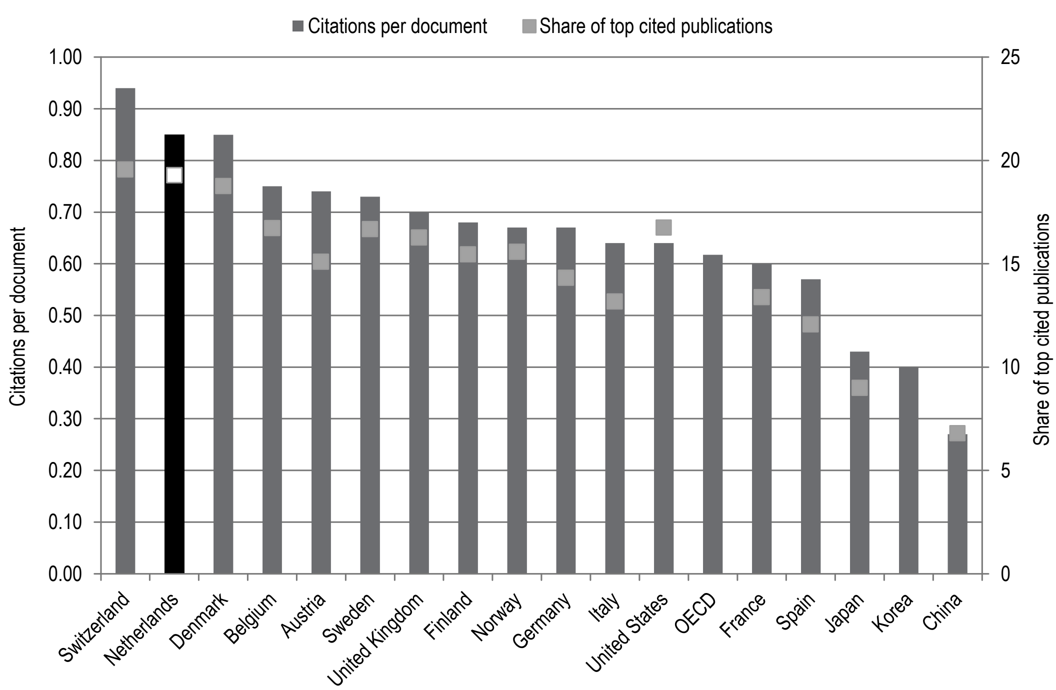
Publications per million population, 2000-11



Source: SCImago Journal and Country Rank.

Figure 3.20. Citations per published paper

Average number of citations, 2012 and share of top cited, 2003-11



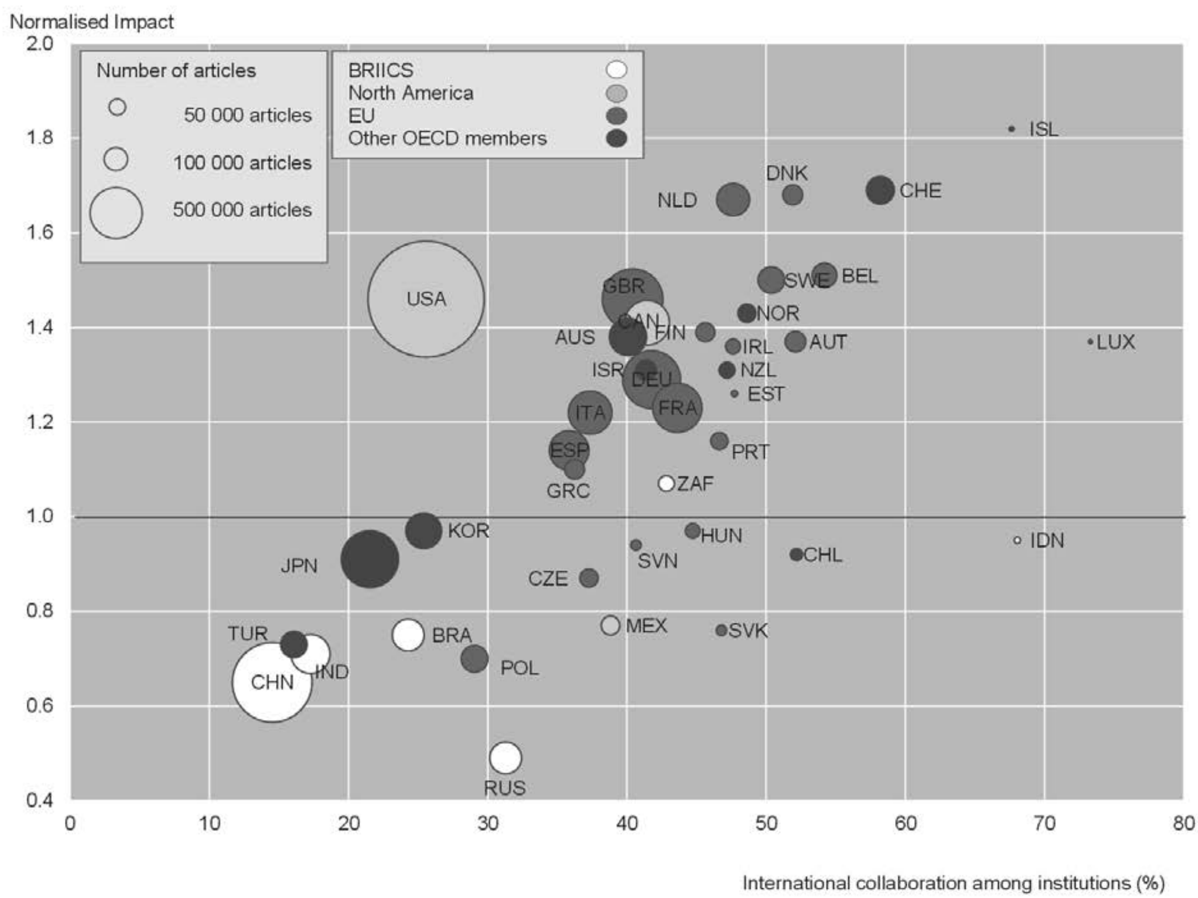
Note: An indicator of research excellence, the "top-cited publications" are the 10% most cited papers in each scientific field. Estimates are based on whole counts of documents by authors affiliated to institutions in each economy.

Source: SCImago Journal and Country Rank; OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

Collaboration and impact are interdependent: increased international collaboration exposes national scientific production to a wider audience and enhances its impact, while greater impact enhances attractiveness as a collaboration partner. Figure 3.21 shows this positive relationship. The Netherlands scores considerably above average on both counts. With respect to international scientific collaboration, the Netherlands ranks after Switzerland and Sweden (Figure 3.22). In an analysis of international collaboration patterns emerging from bibliometric output, den Hertog et al. (2012, p. 71) find that the Netherlands collaborates most intensively with its neighbours, above what would be expected by the relative size of the systems concerned. However, it collaborates considerably less than expected with emerging economies such as India, China, Brazil and Turkey. Collaboration bias towards proximate countries (either in space or culturally) is common, so this is not necessarily a shortcoming of the Netherlands relative to other countries, though the issue may be worth closer investigation.

Figure 3.21. The impact of scientific production and the extent of international scientific collaboration

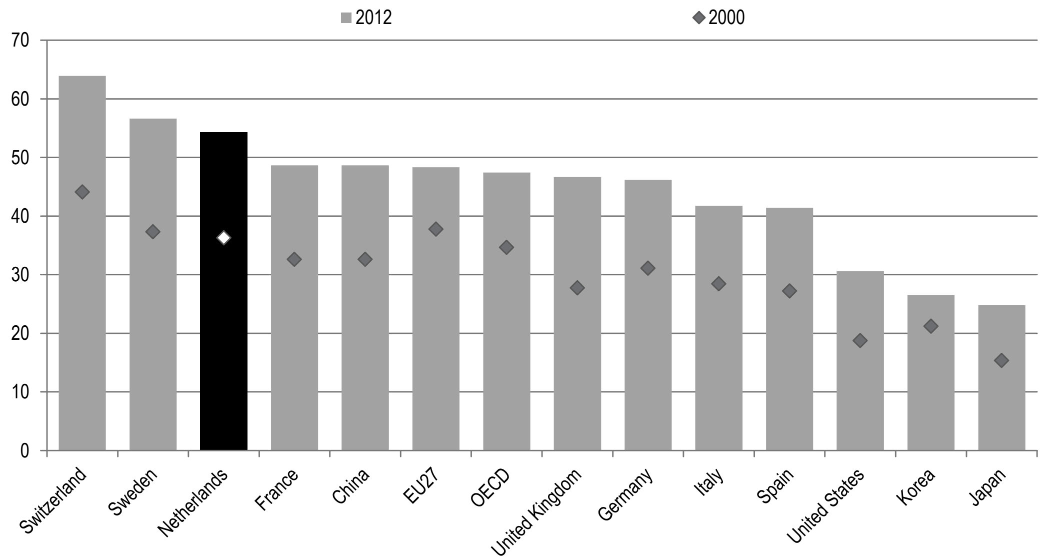
2003-11



Source: OECD (2013b) *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

Figure 3.22. International copublication

Percentage of publications with more than one country of author affiliation, 2000 and 2012



Source: SCImago Journal and Country Rank.

Patents

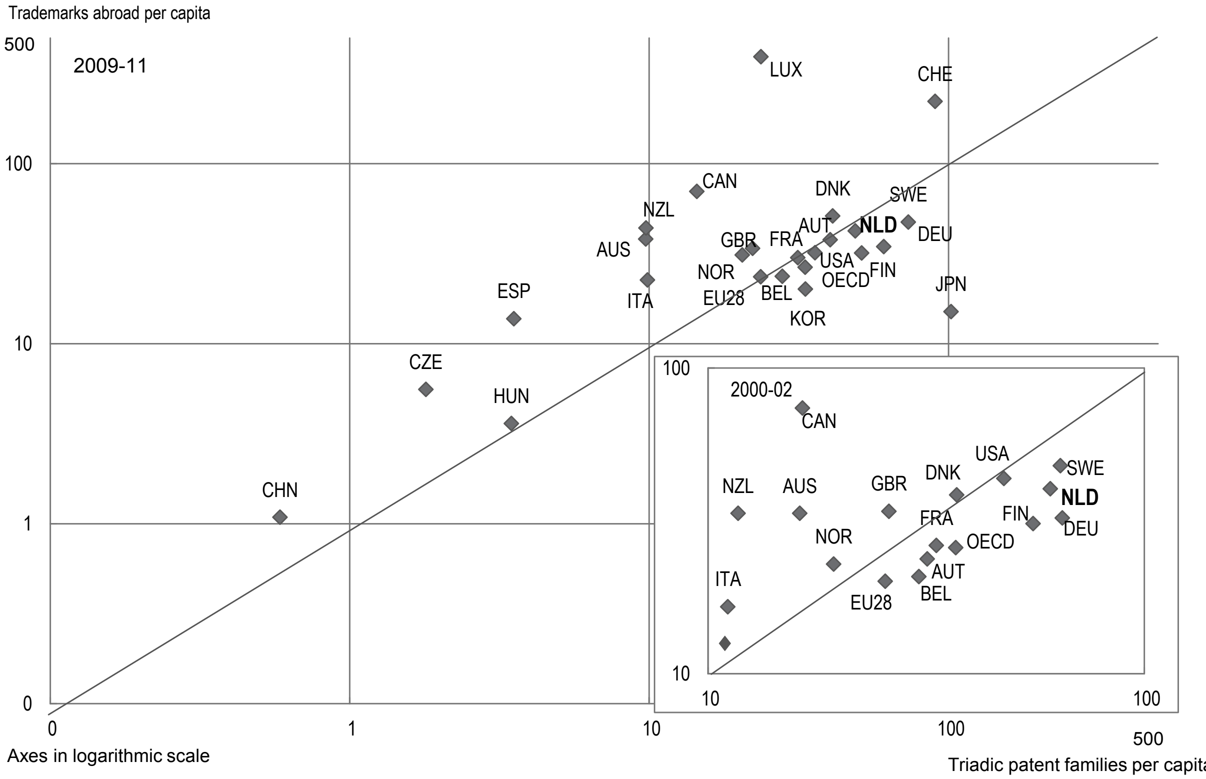
International patenting is considered a measure of the production of economically valuable technological inventions. This indicator is particularly relevant for developed innovation systems with a strong manufacturing sector. One measure of international patenting is the number of triadic patent families, defined as patents applied for at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent and Trademark Office (USPTO) referring to the same invention. Triadic patents are typically of higher value and lessen biases introduced by the geographical coverage of individual patenting offices. The indicator of trademarks abroad is similar in construction, corresponding to the number of applications filed at the USPTO, the Office for Harmonization in the Internal Market (OHIM) [for EU] and the JPO.

Figure 3.23 plots national scores on the two indicators, converted to logarithms to permit comparisons across systems of vastly different magnitudes. The Netherlands is well placed with respect to both triadic patents and international trademarks: it ranks sixth in terms of production of tradic patent families and seventh in terms of trademarks abroad, when compared to OECD and G20 countries. Nevertheless, it ranks behind some other countries with advanced innovation systems on both counts, particularly Switzerland and Denmark.

Companies in countries positioned exactly on the diagonal can be said to have an equal propensity to file for a trademark or to apply for a patent. Countries positioned in the lower half of the figure tend to have a higher trademark intensity than patenting intensity, whereas the opposite is true for countries below the diagonal. The Netherlands is relatively balanced in this regard, reflecting its strengths in both manufacturing and services.

Figure 3.23. Patents and trademarks per capita, 2000-02 and 2009-11

Average number per million population, OECD and G20 countries



Source: OECD Patent Database, June 2013; US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google, May 2013; OHIM Community Trademark Database CTM Download, May 2013; JPO Annual Reports 2001-12, June 2013.

In terms of patent applications to the EPO, the Netherlands is near the top of the comparator group, at a similar level to Finland and Denmark (Table 3.5). It is markedly less patent-intenstive than only Sweden and, especially, Switzerland, a country with exceptionally high patenting activity. As in most European countries, patent intensity peaked around 2006 and then decreased chiefly as a consequence of the economic crisis (the administrative lag also plays a role in the declining trend over time). In the Netherlands, however, contrary to other leading European countries, patenting intensity had not yet recovered by 2013.

Table 3.5. European patent applications to the EPO per million population, 2004-13

Ranked by 2013 patents in 2013

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Switzerland	643	695	745	782	777	760	874	822	845	841
Sweden	276	277	279	298	342	338	386	388	371	385
Finland	300	283	320	379	330	265	303	288	342	350
Netherlands	430	478	452	432	445	405	360	337	302	348
Denmark	179	214	225	252	284	267	327	320	287	345
Germany	278	287	301	306	325	307	334	321	333	325
Austria	122	129	139	163	178	179	208	206	222	237
Belgium	144	162	173	178	177	151	187	181	170	169
France	133	131	131	135	146	143	152	152	156	154
United States	111	110	116	117	122	107	127	112	112	108
Norway	79	70	78	88	100	98	104	93	111	101
United Kingdom	80	77	79	82	82	79	88	75	74	72

Notes: Latest population figures were for 2012 for all countries except Switzerland, where it was 2011. These years were used to calculate the ratio for 2013 (and 2012 for Switzerland).

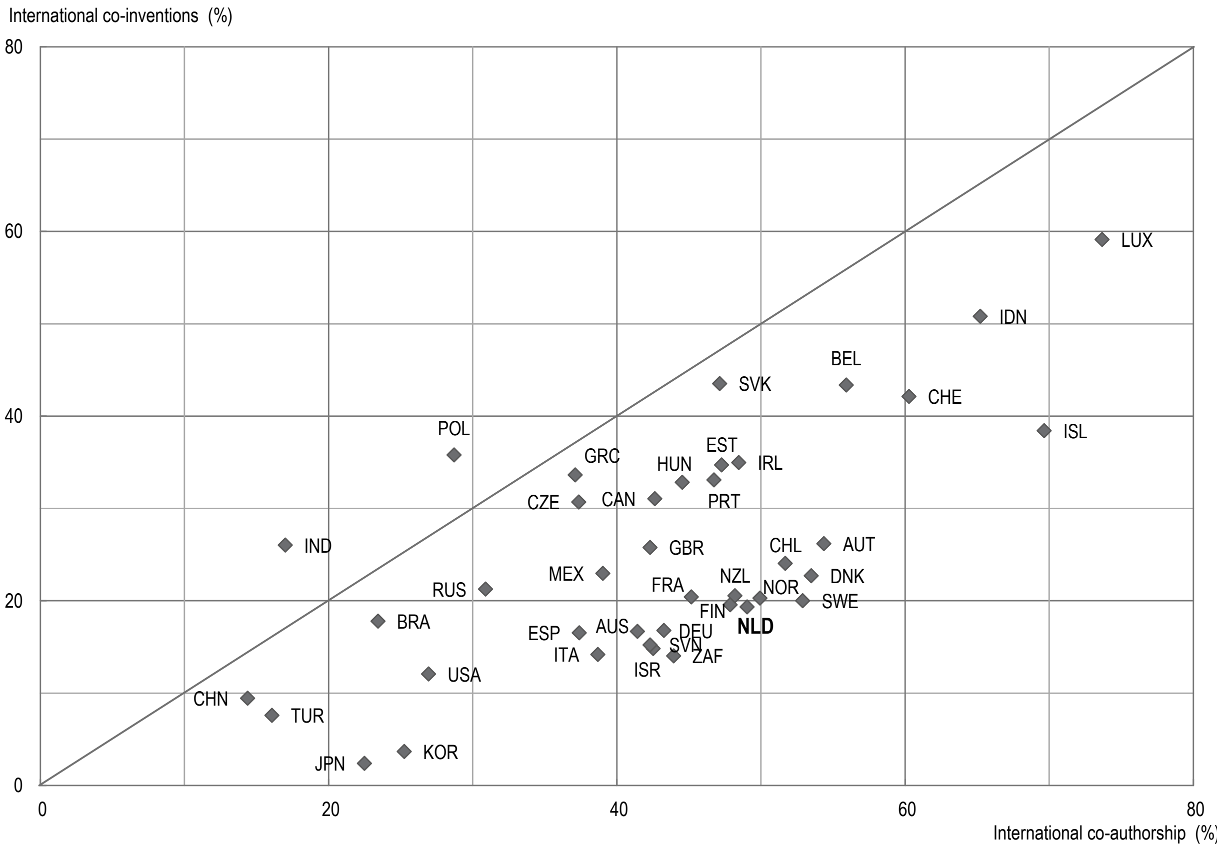
Source: EPO (2014) and Eurostat (2014), Statistics database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

International collaboration can be a channel for technology transfer. However, the reasons behind international connections are not always obvious. International co-patenting, for instance, may signal both arm's-length collaboration and within-firm activities across national jurisdictions, as is often the case for multinational enterprises. High rates of international collaboration may reflect functional similarity (which permits integration into international knowledge production chains), the ownership and location regimes of multinational affiliates, and may also be affected by geographical proximity to major centres of technology production (Maggioni and Uberti, 2009). However, the degree of international collaboration is also affected by the size of national innovation systems. Those large enough to contain entire knowledge production chains and capacities across a wide range of technological areas are less likely to engage in international collaboration.

Figure 3.24 displays international collaboration rates in patenting (co-inventions) and publications (co-authorship). Countries that co-invent tend also to co-author internationally. This suggests that the degree of international collaboration in these two knowledge production settings is at least partly driven by common factors. In the Netherlands, 49% of scientific publications are produced with international partners, while only 19.3% of Patent Cooperation Treaty (PCT) patent applications involve collaboration with international inventors. Most countries in fact have higher shares of international collaboration on scientific publishing than on patent applications. Nevertheless, the share of co-invention is below several OECD countries, including larger advanced systems such as the United Kingdom.

Figure 3.24. International collaboration in science and innovation, 2007-11

Co-authorship and co-invention as a percentage of scientific publications and PCT patent applications



Note: International co-authorship of scientific publications is based on the share of articles with authors affiliated with foreign institutions in total articles produced by domestic institutions. Co-inventions are measured as the share of patent applications with at least one co-inventor located abroad in total patents invented domestically.

Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

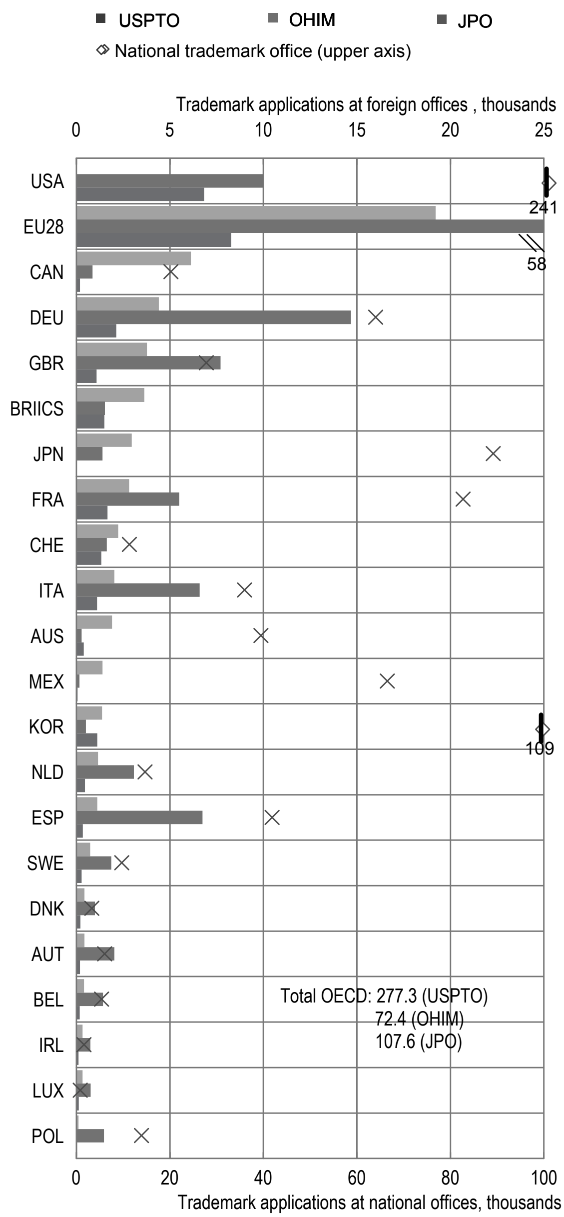
Trademarks

Trademarks are a legal instrument intended to protect distinctive features of a firm such as its brand. Trademarks, like patents, are considered indicators of the generation of economically useful innovations and are therefore considered an indicator of innovation output. Compared to patents, trademarks are especially relevant to innovation in the services sector and are more representative of the activities of smaller firms and of non-technological innovation. In addition, trademarks are well correlated with other innovation indicators (Millot, 2009) as well as with firms' market value (Sandner and Block, 2012) and are a proxy for activity that is closer to the commercialisation stage of innovation (Mendoça et al., 2004).

Figure 3.25 presents trademark applications in three major intellectual property offices (JPO, OHIM and USPTO). The Netherlands displays relatively high numbers of trademark applications at the OHIM, only behind much larger countries: Germany, the United Kingdom, France, Italy and Spain.

Figure 3.25. Top 20 trademark applicants, 2009-11 average

Trademark applications at USPTO, OHIM, JPO and national trademark offices, thousands

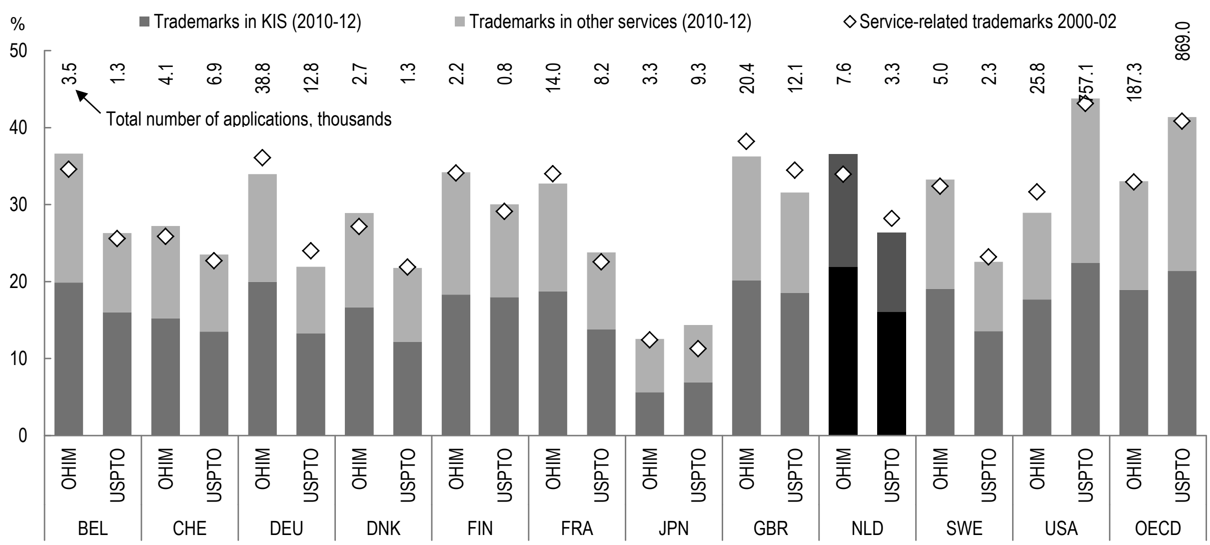


Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en; US Patent and Trademark Office Bulk Downloads: Trademark Application Text hosted by Google; OHIM Community Trademark Database CTM Download, May 2013; JPO Annual Reports 2001-12; WIPO statistics Database, March 2013.

Figure 3.26 presents the share of trademarks in service-sector classes[7] in total trademarks for two periods a decade apart (2000-02 and 2010-12). Over these periods, service-related trademarks increased in importance in the Netherlands at the OHIM but decreased in importance at the USPTO. Trademarks in knowledge-intensive services (KIS) at the OHIM represented 22% of total trademark applications from the Netherlands, the highest value of the countries considered; the share of USPTO KIS trademarks was below the OECD average.

Figure 3.26. Service-related trademark applications at USPTO and OHIM, selected OECD and non-OECD economies, 2000-02 and 2010-12

As a percentage of total trademark applications

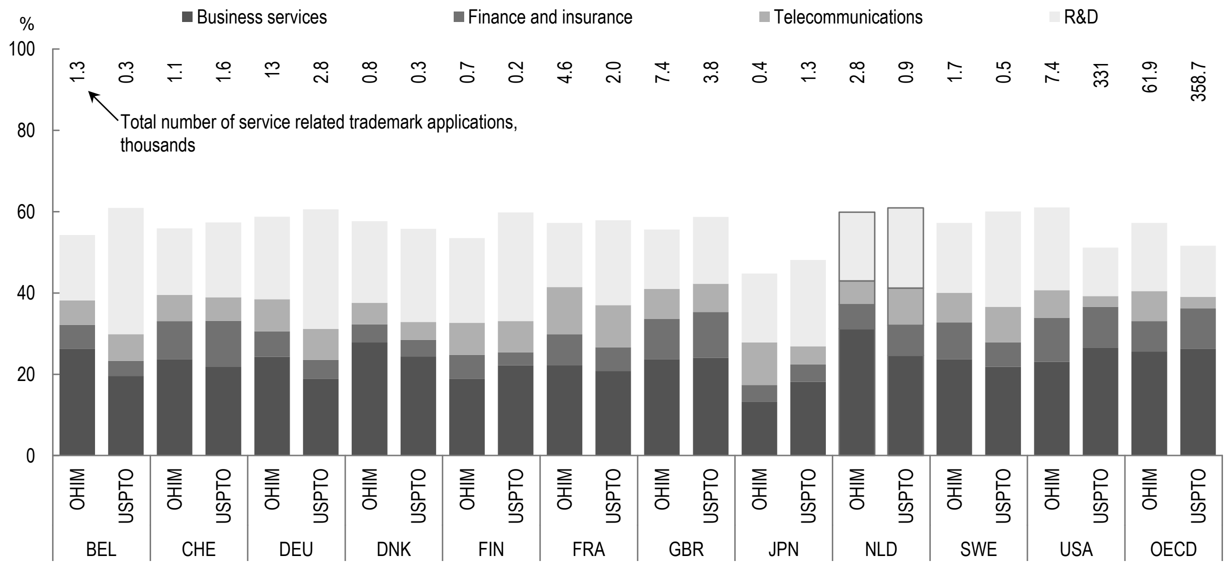


Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

Figure 3.27 shows trademark classes classified as pertaining to KIS[8] as a percentage of total trademarks in service-sector classes and offers a breakdown by type of service (business services, finance and insurance, telecommunications or R&D). Altogether, around 60% of service-related trademarks are in KIS, which places the Netherlands among the leading OECD countries. Most KIS trademarks in the Netherlands were in the business services category (31%, OHIM), and here too the Netherlands leads the OECD.

Figure 3.27. Trademarks in knowledge-intensive services for selected countries, 2010-12

As a percentage of total service-related trademarks



Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

Impact of innovation

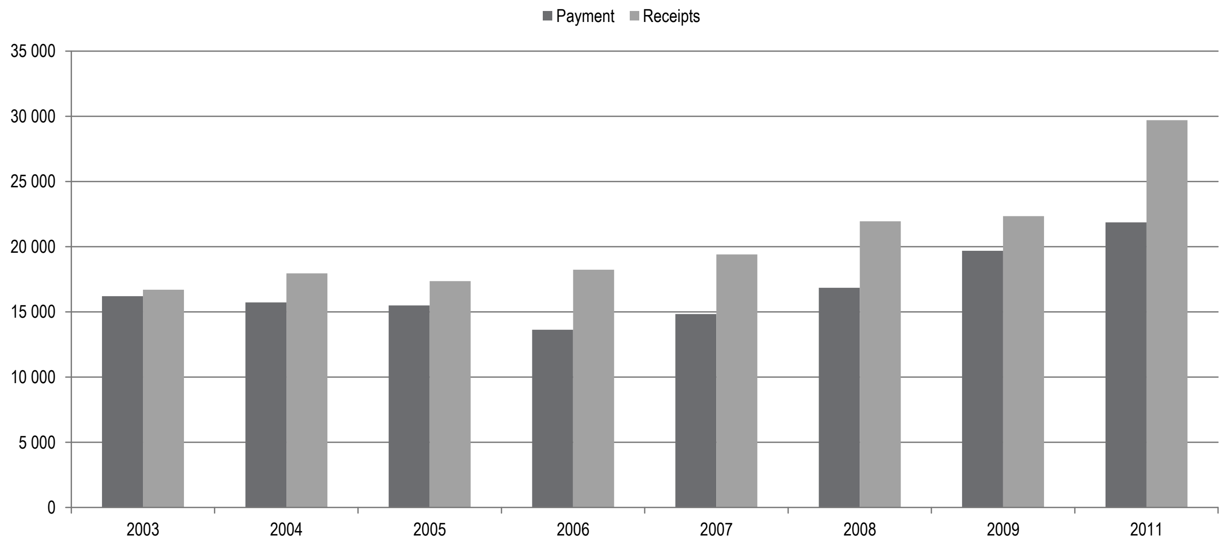
Innovation is a means towards other ends, such as increased profits, productivity, market share, or aggregate economic growth and meeting social challenges. However, few measures of impact are readily available and the ones that exist are only partial. Few patents generate a lot of income and the link between investments in R&D and high-technology exports, for example, is not direct. Therefore the handful of indicators presented here provides only a partial and imperfect picture of the economic value generated by innovation[9].

The technology balance of payments (TBP) corresponds to financial transactions related to international technology transfer. It consists of money paid or received for the acquisition and use of patents, licences, trademarks, designs, know-how and related technical services (including technical assistance) and for industrial R&D carried out abroad (OECD, 2014a). TBP can be a proxy of the market value of the technology produced in a given country and of the presence of framework conditions promoting its appropriation.

For the Netherlands, TBP data show an increase in both receipts and payments, resulting in a positive net balance that was particularly high in 2011, the latest available year (Figure 3.28). In that year, the Netherlands exported around USD 30 billion of technology, while imports accounted for around USD 21 billion. The rising positive net balance is a sign of the ability of the Netherlands to produce economically exploitable innovations. Table 3.6 presents the source of payments and receipts (shares), disaggregated in terms of sale/purchase of inventions, licensing from patents and trademarks, and income from the provision of technology-related services. The largest share of payments and receipts corresponds to patent licensing (over 60%), which is on an increasing trend since 2003. Moreover, in 2011 the balance of payments was positive for all of the reported sub-classes.

Figure 3.28. Technology payments, receipts and balance of payments

Millions of US dollars, constant 2005 prices PPP, 2003-11



Source: OECD, Technology Balance of Payments Database.

Table 3.6. Technology payments and receipts, by source of payments, 2003-11 (%)

Technology payments									
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	n/a	
Sale/purchase of patents and inventions	0.06	0.07	0.12	0.00	0.07	0.28	0.03		0.17
Patent licensing	33.17	32.92	31.30	34.40	37.53	49.34	57.38		63.54
Trademarks, patterns and designs	19.74	17.19	18.38	14.55	15.76	11.79	12.78		10.19
Technology-related services	21.66	25.58	24.47	30.72	30.90	26.61	20.60		16.77
R&D carried out abroad	25.38	24.25	25.74	20.33	15.72	11.98	9.21		9.33
Technology receipts									
	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total (%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	n/a	100.00
Sale/purchase of patents and inventions	0.05	1.11	0.00	2.82	0.03	0.00	0.00		0.25
Patent licensing	42.08	42.03	38.23	38.03	42.42	53.75	57.84		68.65
Trademarks, patterns and designs	12.70	13.53	14.68	14.39	13.21	10.61	12.69		8.50
Technology-related services	25.44	24.77	23.11	21.31	27.38	22.84	19.45		14.10
R&D carried out abroad	19.73	18.55	23.97	23.44	16.95	12.79	10.01		8.50

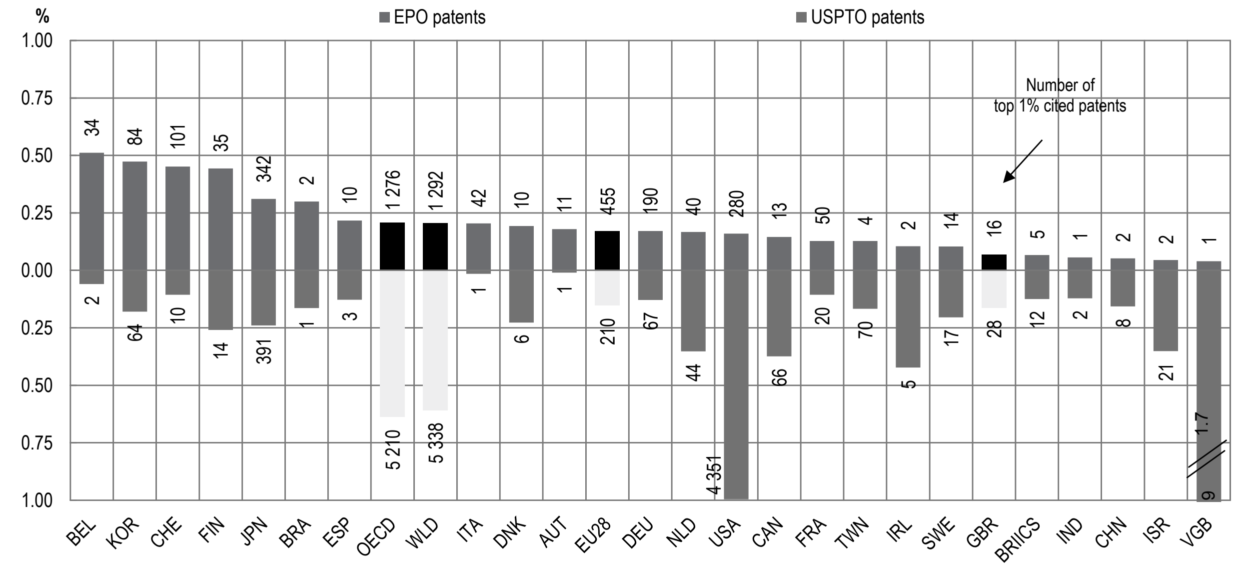
Source: OECD, Technology Balance of Payments Database.

Information from patent citations can also be used to understand the impact of technological output. Figure 3.29 displays the number of top 1% cited patent applications, at the EPO and USPTO over the period 2002-06. These figures should be interpreted with care, as they are based on a denominator with very low counts. The impact of patented inventions from the Netherlands at the EPO is on par with the most advanced innovation systems, even if considerably below Belgium, Korea, Switzerland, Finland and Japan.

The Netherlands is distinguished by a relatively high share of high-impact patents at the USPTO (excluding the United States and the British Virgin Islands, only behind Ireland and Canada), possibly an indication of a tendency to be more selective with USPTO filings and/or of the influence of the activities of multinational enteprises (see section 4.1). Overall, patented technological innovation from the Netherlands appears to have high impact.

Figure 3.29. Highly cited patent applications, 2002-06

Top 1% cited applications, as a share of total EPO and USPTO patents



Source: OECD (2013b), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en; calculations based on the Worldwide Patent Statistical Database, EPO, April 2013.

Notes

1. The change in measurement in 2011 included for the first time "[…] the small-scale and incidental R&D activities of companies […]" (CBS, 2013, p. 157), which is in line with the OECD's Frascati Manual, recommendation that "all enterprises performing R&D, either continuously or occasionally, should be included in R&D surveys" (OECD, 2002, p.128).
2. In June 2013 Statistics Netherlands published revised figures for HERD for the whole period 1999-2011. These changes are not reflected in internationally comparable OECD statistics. However initial estimates suggest that they would imply HERD figures that are lower on average by about USD 400 million than those contained in Figure 2.3, the gap increasing to about USD 500 million for 2008-09 and to about USD 700 million for 2010.
3. If the period considered is 2000-10, the average annual increase drops to -0.4%.
4. According to the revised figures for HERD published by Statistics Netherlands (not reflected in internationally comparable OECD statistics) the share was 0.53%.
5. To give an indication of the magnitude of the change, the difference between the number of business R&D personnel and business researchers was about 25 000, with limited variation over the preceding decade, but it rose abruptly to 42 000 in 2011.
6. International students are students who have crossed borders expressly with the intention to study. The UNESCO Institute for Statistics, the OECD and Eurostat define as international students those who are not residents of their country of study or those who received their prior education in another country.
7. Classes 35 to 45 of the Nice classification (OECD, 2011, p. 62).
8. Business trademark applications designate Class 35; finance Class 36, telecommunications Class 38 and R&D Class 42 of the Nice classification (OECD, 2011, p. 62).
9. As discussed in the last chapter, the Dutch government is making extensive efforts to evaluate the impact of its innovation policy [see e.g. Hassink et al. (2013)].

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Chapter 4

Innovation actors in the Netherlands

This chapter describes the main actors in the Dutch innovation system – business enterprises, higher education institutes and public research institutes – highlighting their respective roles in the development of the innovation system in recent years. It reviews scientific, technological and related functions carried out by the main actors within the system and their contributions to innovation.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

4.1. Business sector

Overall industry profile

The Dutch business sector is very diverse. By some measures, the Netherlands' exports are among the four most diversified in the world (Hausmann and Hidalgo, 2013, p. 21). This is impressive for a country of its size but reflects, of course, the Netherlands role as a gateway to Europe and the large volume of re-exports. Alongside good export performance in high-technology sectors such as electronics and pharmaceuticals (see Chapter 2), the Dutch business sector exports strongly in sectors that are traditionally not considered knowledge-intensive or high-technology, notably in niches of agriculture and food products. These strengths undoubtedly reflect historical patterns of specialisation, but also ability to add value by way of innovation and strategic positioning in global value chains and to build on the country's location at the heart of large European markets.

Since the 1970s, the Netherlands has also developed a sizeable services sector. The shift towards services, both via the development of new services firms and the "servitisation" of traditional industry, reflects to some extent the Dutch economy's diminishing cost competitiveness. Although the services sector overall is afflicted by lagging productivity performance (see Chapter 2), parts of it are internationally very competitive. While these strong points are difficult to capture with traditional export statistics, the performance of the Netherlands on various measures of licensing of intellectual property provides some direct indications of strengths in internationally traded services. Naturally, the contribution of the services sector to the Dutch economy cannot be ascertained simply from measures of its own performance in terms of value added or exports. Transport, logistics, information technology (IT) and not least, finance, provide services that are crucial for the performance of other sectors, including manufacturing.

Table 4.1. Firm demographics in the Netherlands, 2012

	Number of enterprises			Number of employees				Value added			
	Netherlands		EU27	Netherlands		EU27	Comparator group	Netherlands		EU27	Comparator group
	Number	Share	Share	Number	Share	Share	Share	EUR billions	Share	Share	Share
Micro	602 149	91.6%	92.1%	1 438 484	26.8%	28.7%	24.5%	62	20.9	21.1%	23.1%
Small	45 079	6.9%	6.6%	1 102 544	20.6%	20.4%	21.8%	60	20.3	18.3%	18%
Medium	8 497	1.3%	1.1%	1 012 041	18.9%	17.3%	17.8%	67	22.6	18.3%	18%
SMEs	655 724	99.8%	99.8%	3 553 069	66.3%	66.5%	64.1%	189	63.8%	57.6%	59%
Large	1 514	0.2%	0.2%	1 804 649	33.7%	33.5%	35.9%	107	36.2%	42.4%	40.8%
Total	657 238	100.0%	100.0%	5 357 718	100.0%	100.0%	100.0%	297	100.0%	100.0%	100.0%

Note: The comparator group includes Austria, Belgium, Denmark, Finland, France, Germany, Norway, Sweden, United Kingdom (United States excluded owing to lack of data).

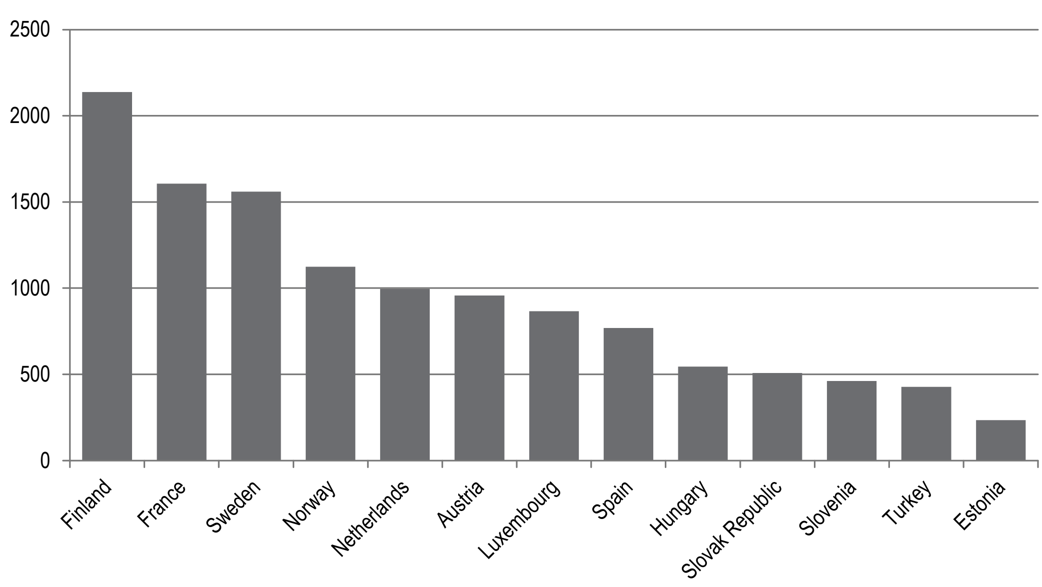
Source: European Commission (2013a), "2013 SBA Fact Sheet The Netherlands", Directorate-General Enterprise and Industry, http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/files/countries-sheets/2013/netherlands_en.pdf; European Commission (2013b), "Database for the Annual Report on European SMEs", Directorate-General Enterprise and Industry, http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm.

The share of the workforce employed in small and medium-sized enterprises (SMEs) is comparable to the EU average, but higher than in the comparator group of countries with advanced innovation systems (Table 4.1). Dutch SMEs, and medium-sized companies in particular, are more productive than the EU and even the comparator group averages, accounting for 64% of value added, as opposed to 57% for the EU. Relative to the EU average, Dutch SMEs are oriented more towards services than manufacturing: manufacturing accounts for about a third less of SME employment than the EU average. Among Dutch services SMEs, 43% are engaged in knowledge-intensive services and 8% in high technology activities, as opposed to 30% and 5%, respectively, in the EU (EC, 2013a; EC, 2013b).

Innovation and R&D performance

The average innovation expenditure of firms (Figure 4.1) can provide useful insight into the scale of innovative effort, not only for R&D but also for the purchase and integration of the latest capital goods, implementation of new processes, training, and additions to the firm's stock of accessible knowledge such as licences. In contrast to expenditure per worker or per some unit of economic output, it is a measure of the scale of expenditure deployed within the firm's boundaries. As such it may better correspond to the size of its R&D projects and of the extent to which innovative effort can overcome the "indivisibilities" often associated with innovation activity. According to the 2008-10 Community Innovation Survey (CIS), the average Dutch innovating firm spent about a million euros on innovation. This puts it ahead of many European countries but at about half of the spending of Finnish firms and about two-thirds that of French and Swedish firms.

Figure 4.1. Average innovation expenditure per innovating company, 2008-10



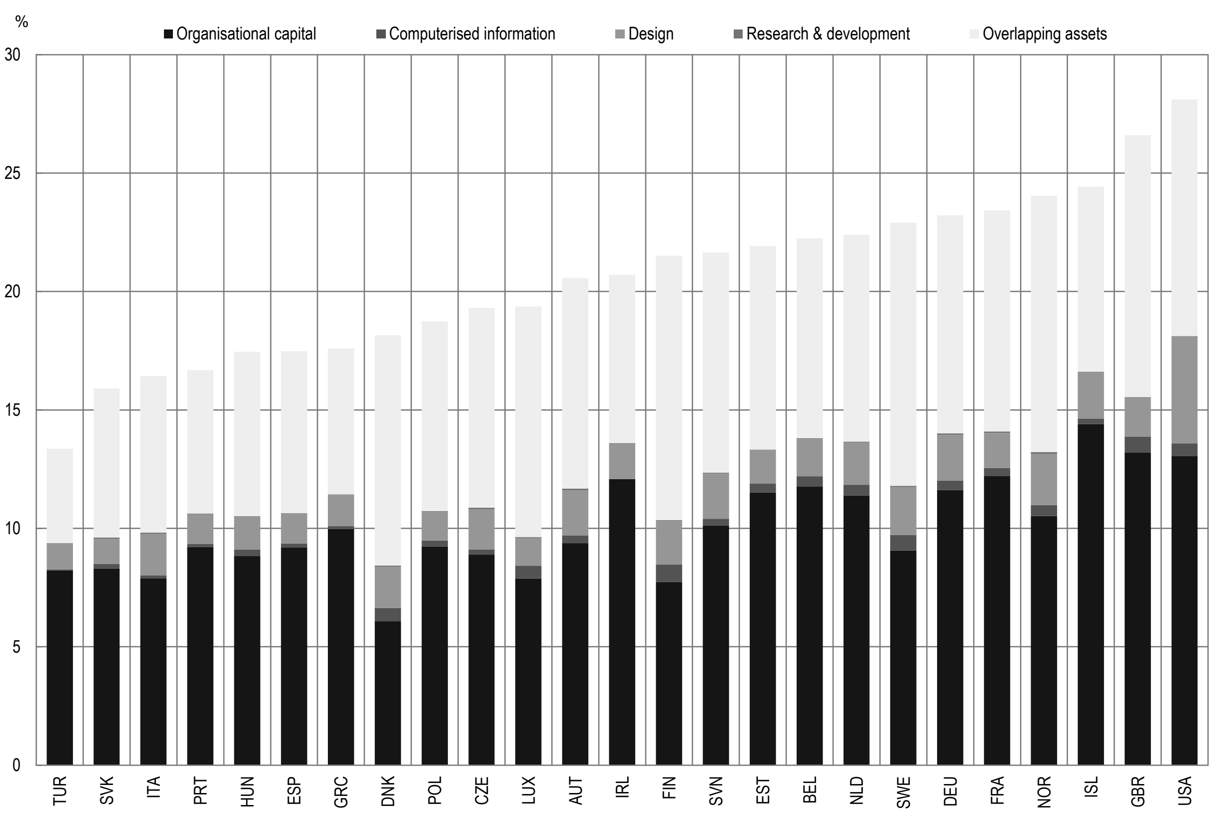
Note: Germany and some non-EU members missing due to lack of data.

Source: OECD, based on Eurostat (2014), "Statistics Database", http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Companies across the OECD use a much larger share of employment and investment for knowledge-intensive activities, such as design and various aspects of engineering, than for R&D. The Netherlands has a relatively high 22% of employment in occupations contributing to R&D, design, software and database activities and to firms' organisational know-how (Figure 4.2). It is ahead of Finland, Austria and Denmark but behind most other countries with advanced innovation systems. Eurostat (2014) figures on the share of employment in industries classified as knowledge-intensive (on the basis of their average propensity to employ tertiary graduates) show a relatively high 36.4%, for the Netherlands, a share that is in keeping with the levels of Finland, Norway and Germany. These employment figures show that the Netherlands possesses the human capital and the production structure that underpin strong innovation systems. They also allow for the possibility that Dutch companies engage in more knowledge-intensive activity than is suggested by the relatively low level of business R&D expenditure. What is relatively certain (as observed in Chapter 3) is that the Netherlands is among the global leaders in terms of its human resources and well positioned to close any gaps in aspects of its current innovation performance.

Figure 4.2. Knowledge-based capital related workers, 2012

As a percentage of total employed persons



Notes: Workers contributing to R&D, design, software and database activities and to firms' organisational know-how account for between 13% and 28% of total employment in many OECD economies (total length of the bar). Of these workers, between 30% and 54% contribute to more than one type of KBC asset (bar "overlapping assets"). R&D is difficult to discern in this graph as it accounts for less than 1% in all countries.

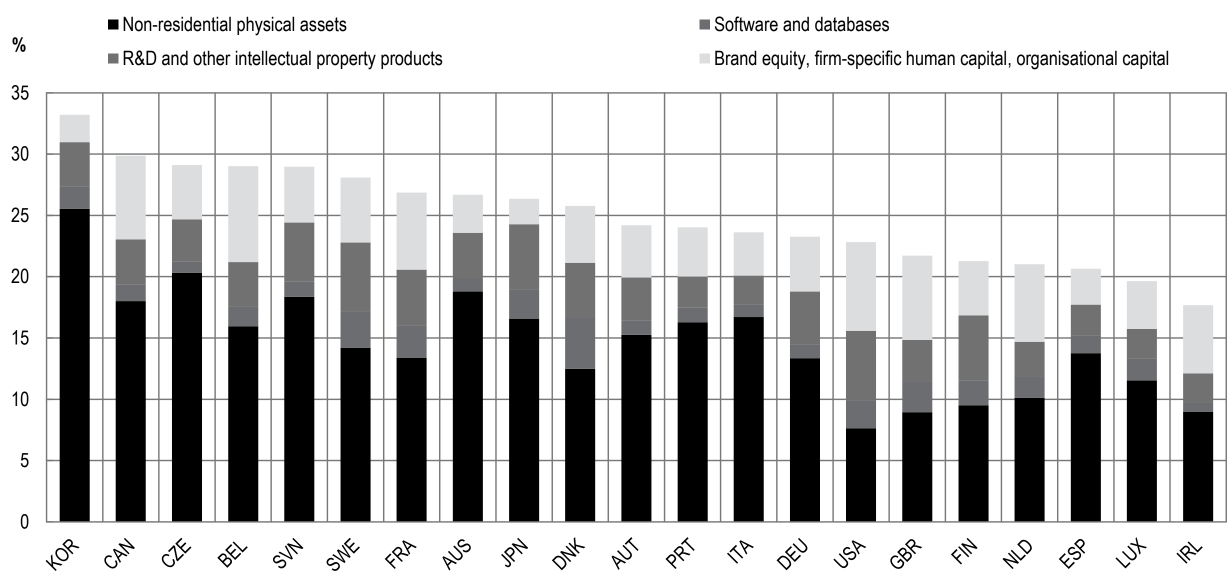
Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

Firms' innovation efforts are largely dependent upon a variety of investments in knowledge assets. These investments enable them to remain successful in their respective markets, without necessarily pushing the global knowledge frontier. Whereas employment figures are suggestive of the current degree of knowledge-intensity, investments can be seen as indicative of firms' preparations for the future.

Figure 4.3 shows investments in knowledge-based capital (KBC), including software and databases, brand equity, firm-specific human capital, organisational capital as well as R&D and other intellectual property, in the Netherlands and other OECD countries. In 2010 the Netherlands had a relatively low level of investment in assets of all types, including non-residential physical capital, partly owing to the pressures of the global economic crisis. In terms of KBC, the Netherlands is better positioned relative to the OECD area, but with 11% of business sector value added, it still trails the United States (15%), Sweden (14%), France, Belgium, Denmark and the United Kingdom (13%). Most of the difference with leading countries is due to relatively weak investments in R&D and other intellectual property assets, followed by software and databases. Dutch firms' investment in brand equity, firm-specific human capital and organisational capital appears on par with other advanced systems.

Figure 4.3. Investment in physical and knowledge-based capital, 2010

As a percentage of value added in the business sector



Notes: For Canada, Japan and Korea estimates refer to 2008. Estimates refer to the business sector for all countries except Korea, for which estimates refer to the total economy. Value added in the business sector is adjusted to include knowledge-based investments. Data on KBC for Australia provided by L. Talbott; all data for Canada provided by J. Baldwin, W. Gu and R. Macdonald; data on KBC and physical assets for members of the European Union, Norway and the United States provided by the INTAN-Invest consortium led by C. Corrado, J. Haskel, C. Jona-Lasinio and M. Iommi; all data for Japan provided by K. Fukao and T. Miyagawa; data on KBC for Korea provided by H. Chun. Data on tangible investment for Australia, Austria, Denmark, Finland, France, Ireland, Italy, Korea, Luxembourg, the Netherlands, Spain and Sweden and data on adjusted value added for Australia, Korea, Luxembourg and Portugal are OECD calculations based on OECD and Annual National Accounts Databases, May 2013.

Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

The Dutch business sector's reaction to the global economic crisis can indicate how it responds to threats and can, symmetrically, be suggestive of its overall evaluation of future opportunities. In particular, changes in firms' investments in different types of assets may reveal the priority accorded to different types of investments as a source of profitability. In 2008-10 business investment contracted, but the contraction varied considerably across countries and for different types of assets. Whereas investment in physical non-residential assets fell across the OECD, some countries increased their investments in KBC assets. In the Netherlands all types of knowledge-based capital investments decreased, in contrast to Belgium and Denmark, and to some extent, Finland, France and Germany[1] (OECD, 2013a, p. 39).

In absolute terms, businesses in the Netherlands spend significantly on R&D. Expressed in constant 2005 USD PPP, Dutch business R&D expenditure (BERD) stood at USD 7.5 billion in 2012, a level comparable to Sweden (USD 7.7 billion), and higher than Switzerland (USD 6.8 billion), Austria (USD 6 billion), Belgium (USD 5.5 billion) and Finland (USD 4.1 billion) (OECD, 2014). However, as shown in Chapter 2, the Netherlands is less R&D-intensive than comparable countries. BERD as a share of GDP in particular is low compared to other countries with advanced innovation systems (Table 4.2). For much of the past decade (and the two preceding decades), BERD intensity has stagnated, declining slightly from just over 1% in 2000 to 0.9% in 2010. It has since increased, but, because important changes in the measurement of BERD were introduced in 2011 (see Chapter 3) at least part of the increase (by EUR 1.6 billion in 2011 in real terms) corresponds to improvements in the measurement of BERD.

Table 4.2. BERD as a share of GDP, 2000 and 2005-12

	2000	…	2005	2006	2007	2008	2009	2010	2011	2012
Austria	..		1.72	1.72	1.77	1.85	1.84	1.91	1.90	1.95
Belgium	1.42		1.24	1.29	1.32	1.34	1.34	1.41	1.52	1.52
Denmark	..		1.68	1.66	1.80	1.99	2.21	2.01	1.96	1.96
Finland	2.37		2.46	2.48	2.51	2.75	2.81	2.72	2.68	2.44
France	1.34		1.31	1.33	1.31	1.33	1.40	1.42	1.44	1.45
Germany	1.74		1.74	1.78	1.77	1.86	1.91	1.88	1.96	1.95
Netherlands	1.07		1.01	1.01	0.96	0.89	0.85	0.89	1.14	1.22
Norway	..		0.81	0.79	0.84	0.84	0.91	0.86	0.86	0.87
Spain	0.49		0.60	0.67	0.71	0.74	0.72	0.72	0.71	0.69
Sweden	..		2.59	2.75	2.51	2.74	2.55	2.33	2.33	2.31
Switzerland	1.82		..	..	..	2.11	..	..	..	2.17
United Kingdom	1.17		1.04	1.06	1.09	1.09	1.10	1.08	1.13	1.09
United States	1.94		1.73	1.79	1.86	1.97	1.96	1.87	1.89	1.95
Total OECD	1.51		1.48	1.52	1.56	1.61	1.59	1.56	1.59	1.62
EU28 (OECD estimates)	1.11		1.08	1.10	1.11	1.14	1.16	1.17	1.22	1.22

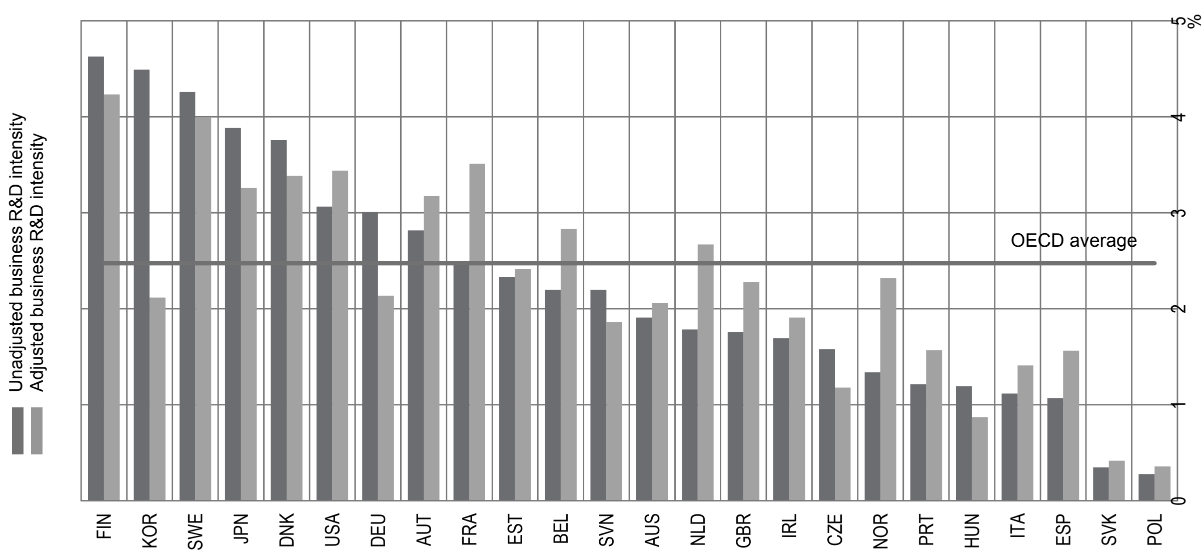
Source: OECD (2014), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

The reasons for the low level of business R&D are the subject of some debate. The literature has attempted to explain it in terms of industrial structure, insufficient collaboration between business and public research institutes, and the internationalisation of R&D (Erken and Gilsing, 2005).

The prevalence of sectors that typically invest little in R&D is certainly an important part of the explanation. Some question the appropriateness of R&D as a measure of innovation for a country with the Netherlands' industrial structure. Clearly, not all sectors are equally prone to engage in R&D. R&D tends to capture innovation activity better in manufacturing, whereas firms in services can innovate without much R&D. At the same time it is important to recall that relatively low levels of R&D intensity may be not only a consequence but also a *cause* of the types of prevalent economic activity.

Irrespective of the sector, however, for a system operating, and competing, at the global frontier, the *scope* of innovation activity – whether new-to-the-world or less ambitious – is of utmost importance. To remain at the global frontier, a sector must sustain or develop its capacity potentially to shift that frontier.[2] Doing so requires a range of innovation capabilities of which R&D is only a part. Nevertheless, R&D is an indicator of innovation input with a reasonable expectation of producing knowledge that is new-to-the-world.[3] Until more holistic indicators of innovation input with a global frontier orientation can be developed (e.g. in the CIS), a critical appreciation of R&D statistics (by e.g. statistically correcting for the varying propensity to perform R&D across sectors) seems a reasonable way of ascertaining proximity to the frontier at the side of inputs.

Figure 4.4. Business R&D intensity adjusted for industrial structure, 2011

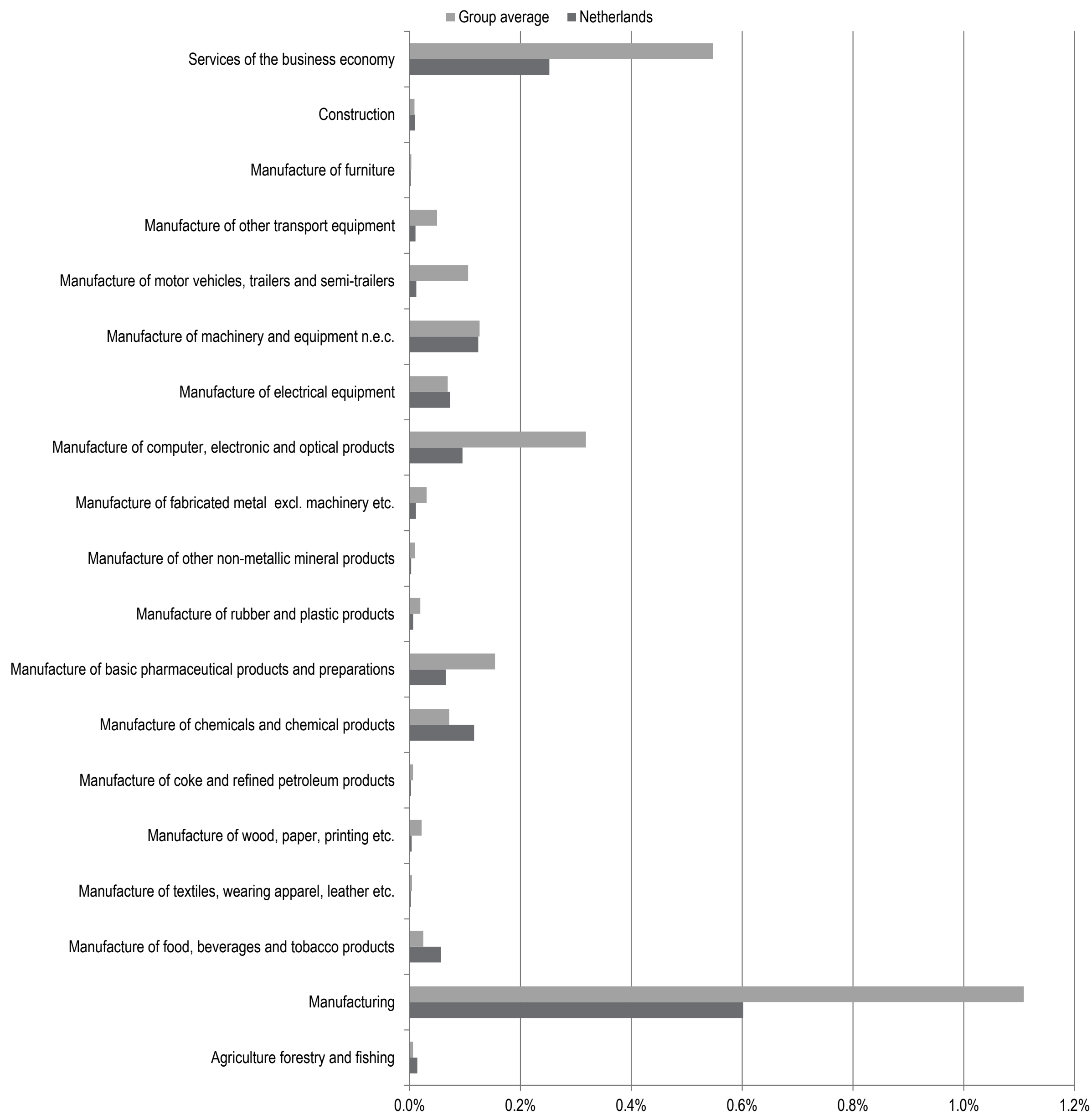


Note: R&D intensity adjusted for industry structure is a weighted average of the R&D intensities of a country's industrial sectors, using the OECD industrial structure's sector value added shares as weights instead of the actual shares used in the unadjusted measure of R&D intensity.

Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

Figure 4.5. R&D intensity across industrial sectors, 2010 or latest years

Expenditure on R&D in the sector as a share of GDP

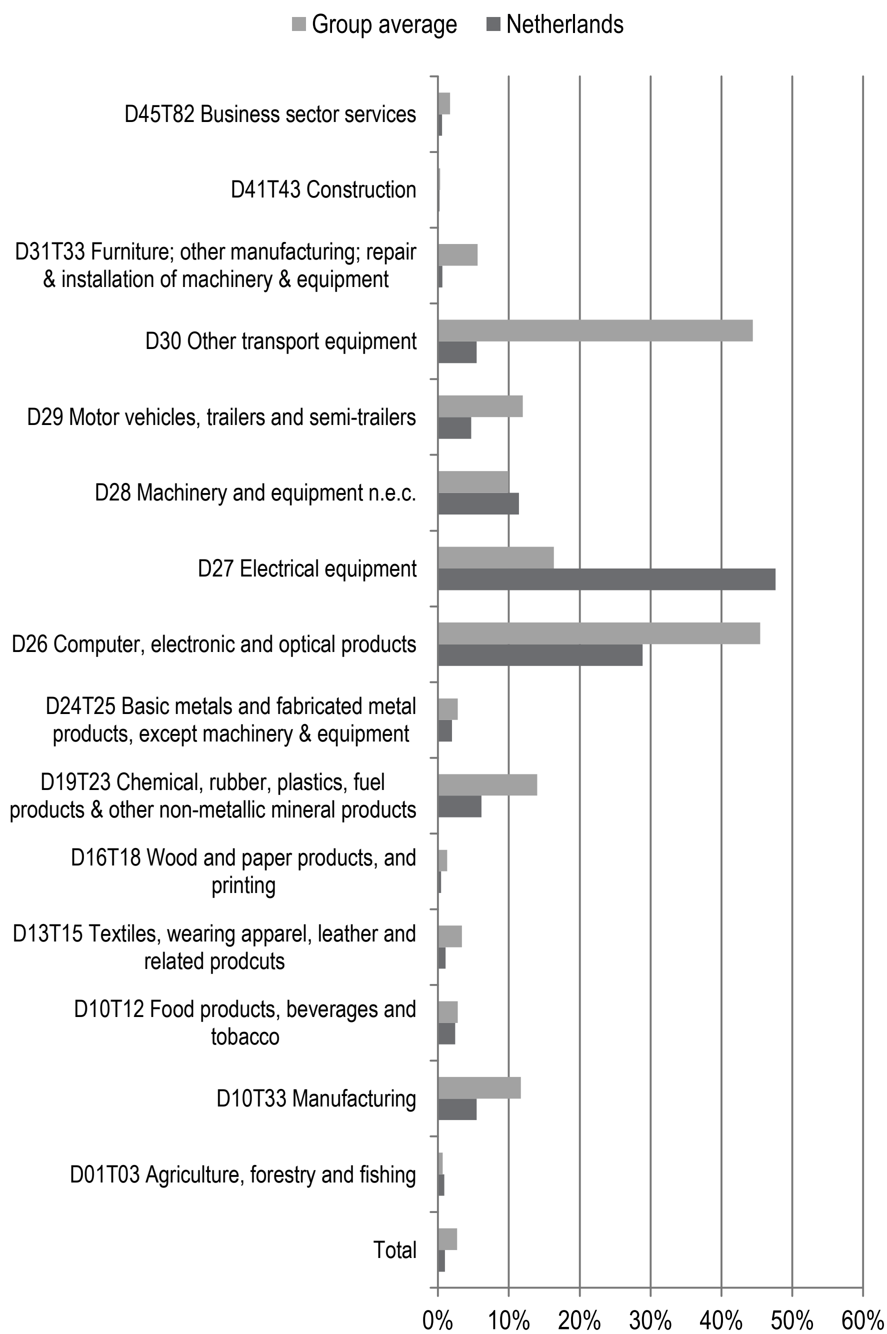


Note: The comparator group includes Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, Sweden, United Kingdom, United States. Latest figures are from 2009 for Austria, Belgium, Sweden, United States.

Source: OECD Research and Development Statistics.

Figure 4.6. R&D intensity across industrial sectors, 2010

Expenditure on R&D in the sector as a share of sectoral value added



Note: Provisional figures. The comparator group includes Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Norway, United States.

Source: OECD Structural Analysis (STAN) Database.

Figure 4.4 presents an attempt to estimate the R&D intensity of countries if they all had the average OECD production structure. In fact, once sectoral structure is taken into account, the Netherlands' share of BERD in GDP increases to just above the OECD average. Nevertheless, it is still behind many comparator countries: Finland, Sweden, France, the United States, Denmark and Belgium.

To evaluate the R&D performance of specific sectors, Figure 4.5[4] compares the R&D intensity of the Netherlands to that of the comparator group average for the same sectors. It is striking that Dutch businesses appear to invest less than their counterparts in countries with advanced systems in all but four manufacturing sectors: food, beverages and tobacco products; chemicals and chemical products, manufacture of electrical equipment; and manufacture of machinery and equipment n.e.c. The gap is particularly pronounced for services of the business economy, and within manufacturing for motor vehicles; transport equipment; computer, electronic and optical products; and basic pharmaceutical products.

The production structure of the Netherlands differs in important ways from that of the comparator group, notably its stronger specialisation in services (see Chapter 1). In the case of services, differences in the production structure may overstate the sectoral R&D deficit observed in Figure 4.5. An alternative indicator of R&D intensity based on R&D expenditures as a share of sectoral value added (comparator group excludes Sweden and the United Kingdom due to lack of data) confirms the main patterns (Figure 4.6).

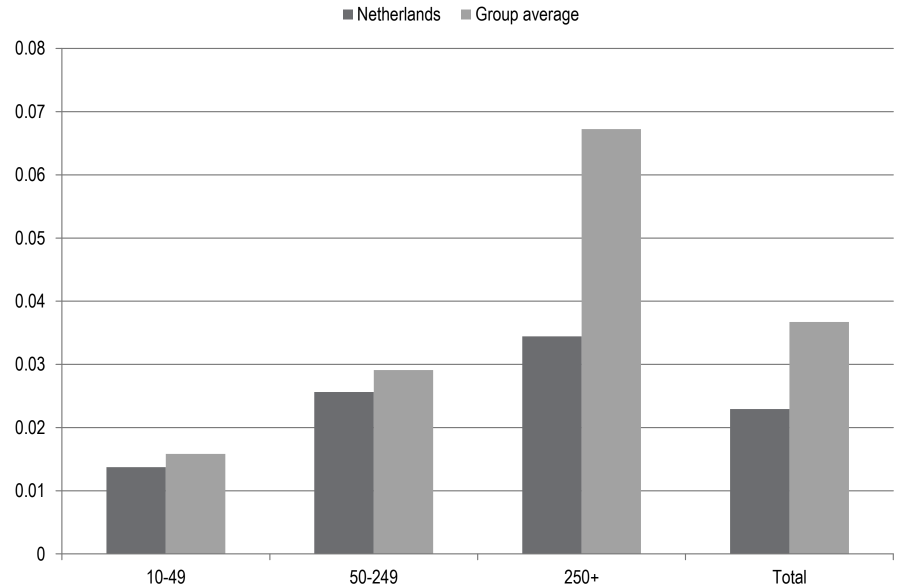
In the Netherlands, SMEs account for about 6% more of total BERD than they do in comparator countries. Aside from that, the distribution of expenditures across firm-size bands does not differ significantly to the reference group of advanced innovation systems. It is however striking that for the R&D intensity of the various size bands (Figure 4.7), the deficit in R&D spending with respect to the reference group is greatest for firms with 250 employees or more.[5] At this level of aggregation it is difficult to say whether the prevalence of the R&D deficit in large firms is a distinct phenomenon or a corollary of the sectoral R&D deficit.[6]

For R&D personnel as a share of industrial employment, the Netherlands is near the comparator group median (Table 4.4). With around 12 R&D workers per thousand, it leads Norway and the United Kingdom, is on par with Belgium and Germany but lags Denmark's 19 workers per thousand. The Dutch business sector displays some distinctive patterns with respect to the employment of R&D workers. Some of these patterns suggest that its R&D activity may be a poorer predictor of efforts dedicated to new-to-the-world (or other ambitious forms of) innovation than in other advanced systems.

First, labour costs account for the lion's share of BERD in the Netherlands, ahead of all countries in the comparator group (Figure 4.8). This appears to be a relatively recent development as in 2005 the Netherlands' share was not much above the comparator group average (Table 4.3). As there are no strong indications of a scarcity of R&D personnel (see OECD, 2012a), this likely reflects an unintended effect of the R&D tax credits, which have traditionally focused on labour costs. One of the evaluations of the effects of the WBSO R&D tax credit over 1997-2004 found that the real effect of the WBSO on R&D expenditure could be 25% higher if there was no effect of the R&D wage level (Lokshin and Mohnen, 2013). This may be due to substitution effects (between R&D workers and other R&D inputs), or alternatively, the extensive expansion of the WBSO tax credit over the past decade may have contributed to the rising costs. It would be important to see whether the introduction of complementary tax incentives for non-labour costs (i.e. capital and exploitation R&D expenditure, as promoted by the RDA scheme, discussed in Chapter 5) has compensated for this.

Figure 4.7. Business enterprise R&D intensity by size class, 2010

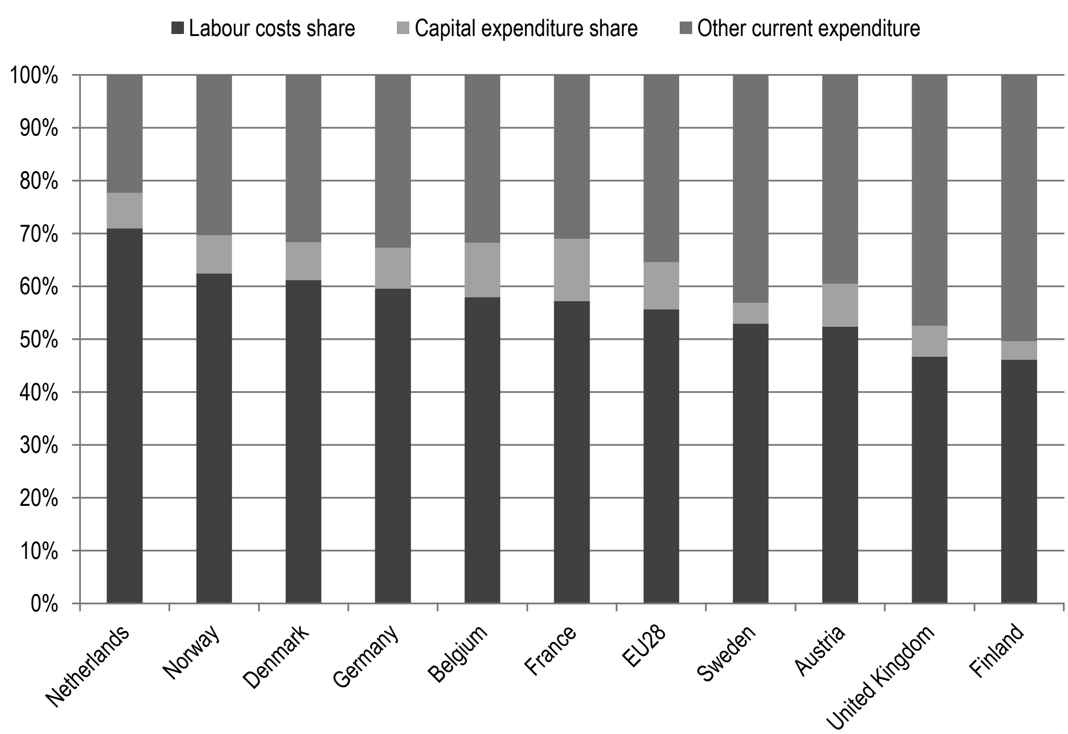
R&D expenditure in the size class as a share of size class value added.



Note: Comparator countries include Belgium, Denmark, Germany, France, Austria, Finland, Sweden, United Kingdom, Norway.

Source: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database; and European Commission (2013b), "Database for the Annual Report on European SMEs", Directorate-General Enterprise and Industry, http://ec.europa.eu/enterprise/policies/sme/facts-figures-analysis/performance-review/index_en.htm.

Figure 4.8. Shares of BERD spent on labour costs and capital, 2011



Source: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Table 4.3. Share of labour costs in BERD, 2005-11

	2005	2007	2009	2011
Netherlands	58%	61%	67%	71%
Comparator group	56%	55%	57%	55%

Source: Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Nevertheless, and despite the increase, estimates of the cost per full-time equivalent (FTE) R&D worker (adjusted for the share of researchers) indicate that labour costs remain low relative to the comparator group[7] (Table 4.4). If there are indeed shortages in the supply of R&D personnel, the relative cost of this type of labour suggests that they are no more pronounced than elsewhere.

Table 4.4. Business R&D personnel in the Netherlands and the comparator group

	R&D personnel in industry	Share of researchers in total R&D personnel, 2009-12 average	Cost per FTE R&D personnel, adjusted estimate*, 2011
	Per thousand employment	%	EUR in 2005 prices PPS
Austria	13.7	57	34 779
Belgium	12.0	61	50 146
Denmark	18.9	61	32 119
Finland	17.5	73	42,957
France	13.1	63	35,499
Germany	11.7	55	43,767
Netherlands	12.2	51	32,616
Norway	10.9	71	41,589
Sweden	18.0	54	33,385
Switzerland	13.4	..	..
United Kingdom	7.0	56	33,165
EU28	8.3	56	..

Note: *Estimates based on aggregate R&D statistics. Costs adjusted to account for the fact that researchers are better paid than other R&D personnel. Cost per FTE personnel is estimated as [L*(RD/RP)]/RP, where L is business R&D labour costs expressed in purchasing power standard (PPS)at 2005 prices, RD is FTE researchers and RP is total R&D personnel.

Source: OECD, based on Eurostat (2014), "Statistics Database", http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database; and OECD (2014), *Main Science and Technology Indicators*, Volume 2013, Issue 2, OECD, Paris, http://dx.doi.org/10.1787/msti-v2013-2-en

Second, researchers account for only 51% of total R&D personnel, behind all comparator countries and the group average of 61%. The Netherlands has historically had a smaller share of researchers in its R&D workforce than countries in the comparator group (and most OECD countries). This likely reflects a strategic specialisation on development rather than research.[8] Moreover, in 2011 the share dropped abruptly to 42%. The gap between numbers of researchers and numbers of R&D personnel grew fastest in 2010-11 (see Figure 3.14 and accompanying note in Chapter 3). In other words, the increase in business R&D intensity in that year coincided with the largest expansion in numbers of non-researchers over the previous decade.

In sum, the business sector has only a moderate R&D workforce for its size. It is largely comprised of non-researchers and has become more expensive over time, which may have reduced the real amount of expenditures devoted to R&D. It nevertheless still enjoys low (adjusted) R&D labour costs in comparison with other advanced innovation systems.

Patterns of innovation output

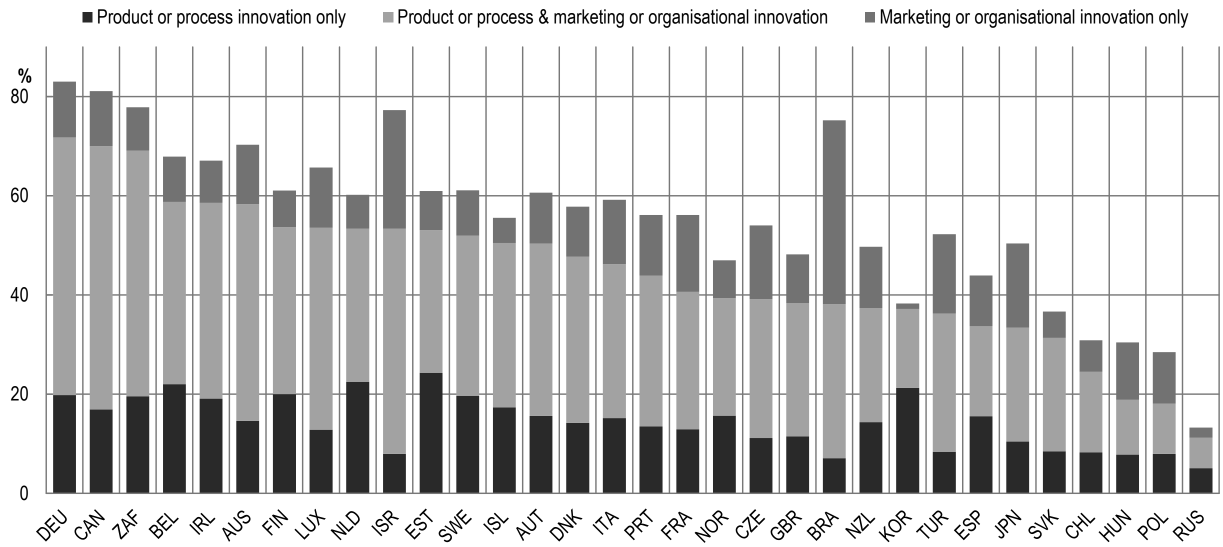
A majority of Dutch firms operating in manufacturing (60%) (Figure 4.9) and services (55%) (Figure 4.10) reported innovation activity in the 2008-10 EU CIS. Aside from Germany's exceptionally high shares of innovating firms (83% in manufacturing and 77% in services), the performance of the Dutch business sector is similar to that of comparable countries. Also as in other countries, the share of innovating firms is somewhat larger in the manufacturing sector. The manufacturing sector has a larger share of product and process innovators (23%) than the services sector (17%). In spite of the services sector's lagging productivity performance (see Chapter 2), it does not appear to innovate less than services sectors in comparable countries. This observation appears in keeping with the dominant explanation for the low productivity of the Dutch services sector: the fact that it is composed of many very small firms. Nevertheless, as over 40% of Dutch services firms do not innovate, innovation would probably make an important contribution to productivity performance.

In manufacturing, 31% of Dutch firms engage in various modes of innovation (product/process as well as marketing/organisational innovation). With the exception of Germany (52%), this is somewhat below countries in the comparator group. In services the difference between the Netherlands and comparable countries is a bit more pronounced, as 27% of Dutch firms engage in various modes of innovation (product/process and marketing/organisational), compared to 32% of Swedish and Belgian firms. If one considers the firms engaging in both product/process and marketing/organisational innovations as a share of total innovators, the Netherlands lags most countries of the comparator group in both manufacturing[9] and services[10].

Empirical analysis has shown that the impact on productivity of different modes of innovation varies across countries and that no single innovation mode is superior (Frenz and Lambert, 2012). On the whole, different modes of innovation can be complementary, so firms that engage in a greater variety of modes can be expected to reap the greatest benefits. In an analysis of firm-level innovation and productivity performance, Polder et al. (2009) find that, in the Netherlands, organisational innovation has the greatest productivity benefits. Importantly, product and process innovation is reported to have had positive productivity effects only when combined with organisational innovation. These results, combined with the somewhat narrower focus on innovation modes relative to peer countries, would suggest that there are potential gains from encouraging firms that are already innovating to engage in a greater variety of innovation modes.

Figure 4.9. Innovation in the manufacturing sector 2008-10

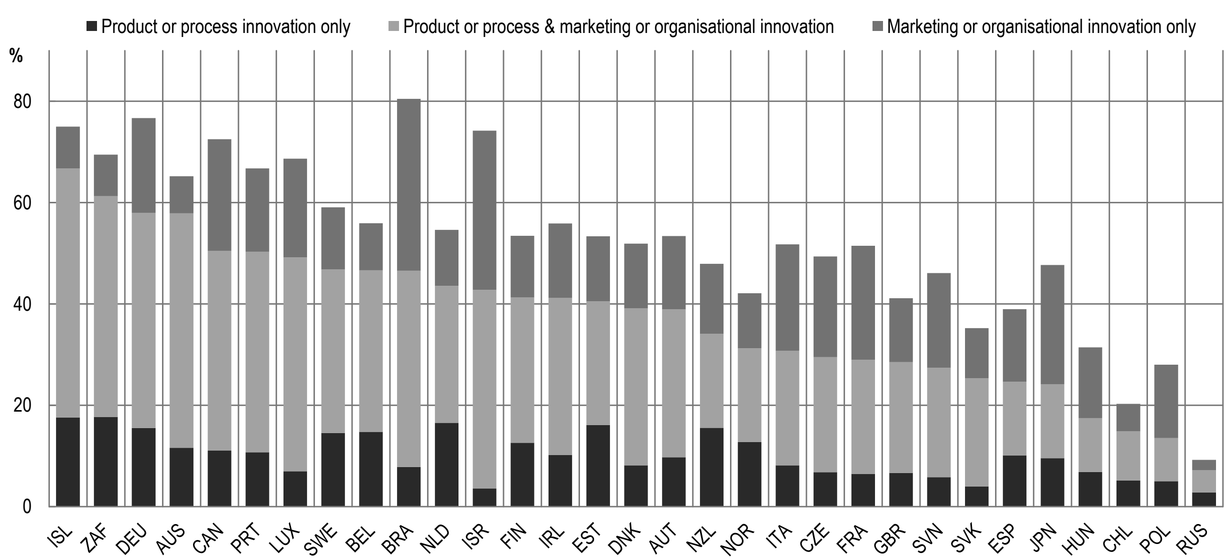
As a percentage of all manufacturing firms



Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

Figure 4.10. Innovation in the services sector 2008-10

As a percentage of all services firms



Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

Despite the low expenditure by business on R&D, the Netherlands is typically among the world's leaders in patenting activity (see Chapter 3), a testament to the presence of some large, globally networked and probably highly efficient R&D spenders. In particular, the Netherlands leads the group in terms of the rate of patenting output obtained per unit of input (Table 4.5). Dutch patenting productivity, measured in either Patent Cooperation Treaty (PCT) applications or triadic patent families, not only leads the group, but considerably outdistances Germany, the second most productive country in this regard. The explanation for this outstanding performance likely has two components. One is scale effects on inventive productivity due to concentration and the ability to overcome "indivisibilities[11]" in R&D. The second is differences in the share of technological output that is patented, owing to patterns of specialisation that favour patenting (e.g. in electronics) over alternative forms of appropriation and/or due to corporate strategies that emphasise generation of intellectual property.

Table 4.5. Patents per business expenditure on R&D, 2008-10 average

	PCT patents per USD 100 million of BERD	Triadic patent families per USD 100 million of BERD
Austria	22.7	5.08
Belgium	23.3	6.22
Denmark	31.6	6.45
Finland	31.3	5.61
France	25.3	6.95
Germany	33.1	9.65
Netherlands	51.1	12.70
Norway	32.2	3.78
Sweden	31.6	7.20
Switzerland	30.0	8.84
United Kingdom	24.3	5.77
United States	16.4	4.66
OECD	22.4	6.38
EU28	28.1	6.93

Note: Owing to lack of continuous BERD data, the figures for Switzerland refer to 2010 only.

Source: OECD (2014), *Main Science and Technology Indicators*, Vol. 2013/2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

With respect to the first likely explanation for high patenting productivity, it appears that patenting activity is highly concentrated in large firms in the Netherlands, with firms employing over 200 employees accounting for 75% of patent applications to the European Patent Office (EPO) (Table 4.6). In addition, the concentration of PCT patents in the top ten companies is the highest for the comparator group (Table 4.7). The Netherlands is unique among the countries examined in terms of concentration in the top patenting company; Philips accounts for about 37% of Dutch PCT patents. Even excluding Philips, the share for the second to tenth firms (36%) is ahead of other countries, with only Switzerland (34%) coming close.[12]

Available evidence on firm-level R&D expenditures is partial and fragmented, but on the whole seems to corroborate the assessment of high concentration. According to a non-comprehensive[13] list of the top 30 R&D spenders in the Netherlands published by *Technisch Weekblad*, the R&D spending (both domestic and abroad) of the top eight companies (Philips, ASML, Shell, Royal DSM, NXP Semiconductors, Unilever, Océ Technologies and KPN/Gentronics) represents 76% of Dutch BERD (de Heide et al., 2013). According to Dialogic (2014) domestic R&D spending by the top five firms in this list (Philips, ASML, KPN, Shell and DSM) amounted to EUR 2.37 billion in 2012, which is equivalent to 32% of BERD. The share of the top five has not changed much over the past decade.

Table 4.6. Concentration of patents in large firms

	Share of EPO patent applications by companies with 200 or more employees	Share of EPO patent applications by companies with 500 or more employees
2000	70%	67%
2005	78%	75%
2010	75%*	66%*

*Provisional figures.

Source: OECD, based on Statistics Netherlands (2014), StatLine, http://statline.cbs.nl

Table 4.7. Concentration of patents and R&D, selected countries

	Share of top 10 firms	Share of top 9 (excluding first firm)	Share of top 10 firms	Share of ICT patents over total PCT patents	Share of top 10 R&D investors in BERD
	(Patents with priority date 2011)		(sum of patents with priority dates 2000-11)	(2009-11 average)	(2010; 2008 for Switzerland)
Austria	25%	19%	16%	20%	12%
Belgium	31%	27%	36%	23%	33%
Switzerland	41%	34%	29%	21%	205%
Germany	30%	20%	26%	22%	69%
Denmark	29%	25%	31%	19%	65%
Finland	67%	30%	65%	40%	115%
France	32%	29%	31%	28%	58%
United Kingdom	25%	19%	20%	29%	72%
Netherlands	73%	36%	79%	31%	106% (excl. EADS)
Sweden	59%	18%	51%	32%	76%
United States	14%	11%	11%	36%	24%

Note: For the first three columns, top firms were identified according to the number of PCT patents filed over 2009-10. Patent applicant names in the OECD HAN database were harmonised using a series of automated cleaning and string matching algorithms. The number of patents may be underestimated for some companies.

Source: OECD, Calculations based on the Worldwide Patent Statistical Database (PATSTAT), EPO, October 2013 and HAN Database, OECD, January 2014; OECD (2014), *Main Science and Technology Indicators*, Volume 2013, Issue 2, OECD, Paris, http://dx.doi.org/10.1787/msti-v2013-2-en; and European Commission (2011), *The 2011 EU Industrial R&D Investment Scoreboard,* http://iri.jrc.ec.europa.eu/scoreboard11.html.

The EU Corporate R&D Investment Scoreboard (EC, 2011) potentially allows for a cross-country view, with the important caveat that companies' nationalities are assigned according to the location of their headquarters. Although the Netherlands does not lead the comparator group, concentration by the top firms (excluding EADS for the Netherlands) is on the high end (last column of Table 4.7). Account should be taken not only of the effect of the location of headquarters but also of the fact that that in the Netherlands SMEs account for a slightly larger share of total BERD than in comparator countries. Therefore, if the concentration of R&D in the top ten firms is not entirely due to the headquarters effect, it is likely an indication of partial concentration at the upper end of the distribution, which is counterbalanced by partial concentration in the lower end.

The concentration of patenting and R&D expenditures by the top firms suggests that, despite its small size, the Netherlands is well positioned to exploit scale economies in R&D, particularly in the case of patented technological innovations. It has also managed largely to sustain the R&D commitments of large firms in the Netherlands over a period of considerable internationalisation of R&D (discussed below).[14]

With respect to the second likely explanation for high patenting productivity, one may examine the concentration of patenting in fields considered to have a higher propensity to patent, such as information and communication technologies (ICT). With the notable exception of software (which is not patentable in Europe), companies active in the ICT sector are prone to use patents and do so as part of their corporate strategy, as suggested by a number of well-publicised litigation cases. The second-to-last column of Table 4.6 gives the share of ICT patents in total PCT patent filings, and it too positions the Netherlands at the high end of the comparator group. In fact, looking at its global share of ICT patents (not included Table 4.6), the Netherlands ranks eighth, ahead of Sweden, Finland and Switzerland (OECD, 2012b).

The Netherlands performs well on other measures of intellectual property that can be used as proxies for innovation, such as trademarks. As seen in Chapter 3 it is at the upper end of the comparator group in terms of international trademarks per capita, though it lags countries with smaller services sectors such as Sweden and Switzerland. The pattern of trademarks is also suggestive of the types of service innovation most prevalent in the Netherlands. The top two trademark application fields were advertising and business services and leisure and education, while ICT and audio-visual led in France, Finland and the United States and health, pharmaceuticals and cosmetics in Denmark and Switzerland (OECD, 2013a, p. 187). Other intellectual property instruments such as designs suggest a Dutch specialisation in electricity and lighting and in furniture and household goods (OECD, 2013a, p. 187).

Globalisation and its impact on business innovation

Historically R&D was rarely outsourced, but this changed in the 1990s (Mol, 2005). An apparent intensification of outsourcing of R&D activities by Dutch firms and a parallel inability to attract much internationally mobile R&D investment prompted policy concern and intense debate, particularly at the beginning of the past decade (e.g. Erken and Gilising, 2005).

Unfortunately, national statistics on the R&D activities of Dutch firms abroad were not available at the time of the review. A partial view of the situation may be obtained from other sources. The OECD's Technology Balance of Payments Database tracks R&D carried out abroad, most of it by businesses. In 2011 Dutch actors had commitments of USD 1.98 billion, but in relative terms these were no greater than in comparable countries (Table 4.8). In that year Dutch actors, largely Dutch multinational enterprises, performed the equivalent of 28% of BERD abroad, down from 65% in 2003. Philips maintains R&D laboratories abroad, in both advanced (Germany, United Kingdom, United States) and emerging (China, India) markets. About a quarter of its R&D workforce in 2012 was located outside the Netherlands (see Box 4.1).

Table 4.8. R&D carried out abroad as a share of BERD

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Netherlands	65%	58%	62%	42%	37%	35%	33%	32%	28%
United Kingdom	9%	14%	15%	15%	14%	23%	24%	26%	23%
United States	2%	3%	3%	4%	5%	6%	6%	8%	9%
Sweden	38%	37%	38%	39%	45%	46%	46%	44%	39%
Norway	5%	6%	10%	11%	11%	11%	11%	11%	0%
Germany	11%	11%	12%	12%	13%	12%	15%	16%	15%
Finland	0%	0%	46%	46%	41%	70%	64%	66%	60%
Denmark	0%	0%	13%	14%	15%	14%	12%	15%	20%
Belgium	20%	28%	28%	24%	21%	43%	51%	48%	31%
Austria		5%	5%	6%	6%	7%	8%	6%	7%

Source: OECD Technology Balance of Payments Database and Main Science and Technology Indicators.

Box 4.1. Large, R&D-intensive multinationals in the Netherlands

Philips

Royal Philips (commonly known as Philips) is one of the world's largest electronics companies, employing around 115 000 people in over 100 countries. In 2013 recorded sales amounted to EUR 23.3 billion. Philips has three main thematic divisions: Healthcare; Consumer Lifestyle; and Lighting, as well as an Innovation, Group and Service division, employing 32%, 16%, 42% and 12%, respectively, of its personnel.

According to its 2012 Annual Report, emerging economies accounted for 10% of sales growth. Mature economies accounted for only 1% of sales growth between 2011 and 2012. In 2012, emerging economies represented 35% of total sales (33% in 2011).

R&D expenditures increased from EUR 1.6 billion in 2011 to EUR 1.8 billion in 2012 (i.e. above the 2008 pre-crisis level of EUR 1.7 billion). As a percentage of sales, R&D expenditures increased from 7.1% in 2011 to 7.3% in 2012. In Healthcare, R&D investments increased mainly in Imaging Systems and Home Healthcare Solutions (an increase of EUR 63 million from 2011 to 2012). In Lighting, R&D expenditures increased by EUR 44 million from 2011 to 2012. In Consumer Lifestyle, however, R&D spending decreased by EUR 12 million. Additional R&D investments by the Innovation, Group and Services divisions created new value spaces and launched innovation and design initiatives.

Philips R&D centres are located throughout the world (two in Asia-Pacific, five in Europe, Africa and the Middle East and one in North America). Most Philips research personnel are located on the campus in Eindhoven, the Netherlands (1 500), followed by Briarcliff, United States (125), Shanghai, China (110), Hamburg, Germany (100), Aachen, Germany) (70), Cambridge, United Kingdom (35), Bangalore, India (30).

Source: Philips.com, Philips Annual Report 2012.

ASML

Since 2002, ASML is a producer of lithography systems for the global semiconductor industry. Its headquarters are in Veldhoven, the Netherlands. ASML was created in 1984 as a joint venture between Philips and Advanced Semiconductor Materials International (ASMI). Philips pulled out of the venture in 1994. In 2013, ASML employed 10 360 people and is present in more than 70 locations in 16 countries.

In 2013, the company invested EUR 882 million in R&D (net of credits, EUR 589 million in 2012 and EUR 590 million in 2011). Its R&D budget is extensively used to sponsor joint developments with suppliers and technological partners. ASML manufacturing and R&D centres are located in Connecticut and California in the United States, in the Netherlands in Europe and in Chinese Taipei in Asia. Technology development and training centres are located in Japan, Korea, the Netherlands, Chinese Taipei and the United States.

Source: ASML website and Annual Report 2013.

.../…

Box 4.1. Large, R&D-intensive multinationals in the Netherlands *(continued)*

DSM

Royal DSM is an international company active in the health, nutrition and materials sectors. Its products include food and dietary supplements, personal care devices, pharmaceuticals, medical devices, alternative energy and bio-based materials. In 2012, DSM had net income of EUR 437 million and employed more than 23 000 people on five continents. In 2012, 38% of sales were in emerging economies, 20% in North America and 36% in western Europe.

R&D expenditures in 2012 amounted to EUR 490 million. The DSM Innovation Centre was created in 2006 to integrate innovation in the company's strategic orientation and has been expanding. It employed 668 people in 2012 (383 in 2011) and its R&D investments were EUR 61 million in 2012 (EUR 42 million in 2011). Open innovation approaches are considered an essential part of its efforts. DSM also invested in the development of new R&D facilities: a biotechnology centre in Delft, two centres on material sciences in Geleen (the Netherlands) and in Singapore. The company is also active in venture capital investments in different countries.

Source: www.dsm.com; DSM (2013) At a Glance Factbook,
www.dsm.com/content/dam/dsm/cworld/en_US/documents/company-presentation.pdf;
www.dsm.com/content/dam/dsm/cworld/en_US/documents/factbook-2013.pdf.

Shell

Shell is a global energy and petrochemical company employing around 87 000 people in more than 70 countries. In 2005 Royal Dutch Shell and Shell Transport and Trading were reorganised into a single company. The headquarters of the resulting company (Royal Dutch Shell plc.) is in The Hague. In 2012, Shell's income was USD 26.8 billion and the company invested USD 1.3 billion in R&D.

Shell has three main technology centres located in the Netherlands, India and the United States. These were chosen as strategic locations for the company's business, with access to world-class researchers and scientists. The first laboratory was created in Amsterdam in 1914 and now hosts around 1 300 people. The US centre is located in Houston, Texas, and employs over 2 000 scientists and engineers. A third large R&D centre is under construction in Bangalore, India, to replace two existing sites, with 1 500 researchers. In addition, smaller-scale technology centres are located in Germany, Canada, Norway, China, Oman and Qatar.

Source: www.shell.com.

NXP Semiconductors

NXP Semiconductors is one of the world's leading companies in semiconductor manufacturing. It was created in 1953 as a division of Philips (Philips Semiconductors) in Nijmegen, the Netherlands. Philips sold the company in 2006. It was renamed NXP and is now headquartered in Eindhoven. NXP employs approximately 24 000 people (of whom 8 000 based in China) and operates in more than 25 countries. NXP produces semiconductor components used in smart devices such as wireless infrastructure, cyber-security, automotive, lighting, mobile and computing applications. The company's strategic orientations include energy efficiency, connected devices, security and health. NXP revenue in 2013 amounted to USD 4.82 billion. Identification devices accounted for 28% of revenue, automotive components 22%, portable and computing components 10%, infrastructure and industrial solutions 16%, other standard products 24%.

NXP invested USD 639 million in R&D in 2013 and employs 3 300 R&D staff. R&D is performed in Asia, Europe and the United States (manufacturing takes place in Asia and Europe). There are design and engineering teams in 21 locations. The company is active in joint ventures and/or participation in companies in various countries.

Source: NXP.com.

UNILEVER

Unilever was established in 1929 as a merger. Today it has more than 400 brands in the fields of food and nutrition, soap and shampoo, and everyday household-care products. Unilever employs around 173 000 people and has 252 manufacturing sites across the world. Unilever products are sold in more than 190 countries and generated a sales volume of EUR 51 billion in 2012, with emerging markets accounting for 55% of the company's business.

…/…

Box 4.1. Large, R&D-intensive multinationals in the Netherlands *(continued)*

UNILEVER *(continued)*

Over 2003-12 the company invested approximately EUR 1 billion a year in R&D, or about 2% of turnover. Over 6 000 people are employed in R&D in 20 countries. Unilever has six research centres: in Trumbull, United States (400 people), in Colworth and Port Sunlight, United Kingdom (600 and 750, respectively), in Vlaardingen, the Netherlands (1 000), in Bangalore, India (300) and in Shanghai, China (450). R&D project teams increasingly collaborate with academic partners. Unilever researchers have a background in various fields: bioscience, structured materials, advanced measurement and data modelling, consumer perception and behaviour, nutrition and health. Unilever tightly links its marketing, R&D and product development efforts, tailoring them as far as possible to the demands of national markets.

Source: www.unilever.com/innovation/innovationinunilever/; www.unilever.com/images/ir_Charts-2012_tcm13-348370.pdf.

Océ Technologies

Océ develops and produces printing and copying machines, ink-jet technologies and related software. The company's origins date back to 1857 when the two founding families created a pharmacy in Venlo, where the company's headquarters are still located today. In 1930 it brought chemical innovations to the market and the Océ brand was created. Océ is now active in more than 100 countries and employs more than 20 000 people globally. In 2010, Océ was acquired by the Canon Group. The two companies have combined their printing activities in order to create the largest digital printing consortium.

In 2011 Océ invested EUR 174 million in R&D (EUR 183 million in 2010 and EUR 225 million in 2009). Océ has research centres in nine countries, which employ more than 1 500 professionals. The Dutch research centres are located in Venlo and Eindhoven. Other centres are located in Belgium, Canada, France, Germany, Romania, the United States and Singapore. Océ is part of the PrintValley consortium together with 22 other companies and Dutch knowledge institutions.

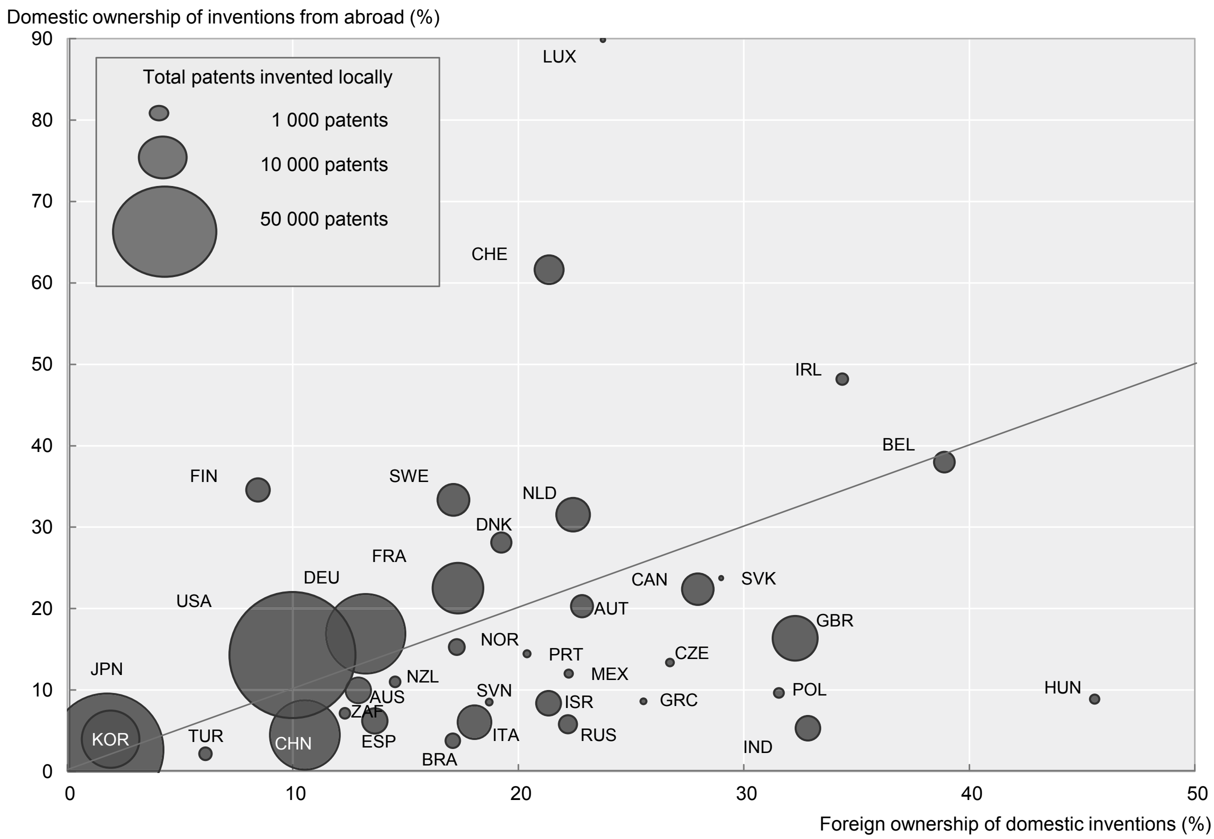
Source: http://global.oce.com/.

Additional indirect evidence can be gleaned from patenting. Differences in the owner's and the inventor's country of residence may be due to the activities of multinationals: the owner is an international conglomerate and the invention is that of a foreign subsidiary (OECD, 2013a). However, multinationals may also choose to assign ownership of intellectual property to a part of the company registered in a location with preferential tax treatment for the licensing and/or use of knowledge capital. At 32%, the share of domestically owned but foreign-invented patents (vertical axis in Figure 4.11) places the international R&D activities of Dutch companies at a level similar to that of Sweden and Finland. As both Sweden and Finland have substantially higher financial commitments abroad than the Netherlands (Table 4.8), their equal position on this dimension may point to the importance of the Netherlands as a preferential location for headquarters and/or to the attractiveness of the Dutch tax regime.

With respect to the foreign ownership of domestic inventions (horizontal axis in Figure 4.11), at 22% the Netherlands occupies a position similar to that of Switzerland, Austria and Israel. This can be partly seen as an indirect indication of the attractiveness of the Dutch innovation system for foreign R&D investment. However, a non-negligible part (by some estimates close to a third[15]) may reflect the complicated ownership structure of companies that ultimately remain under Dutch control.

Figure 4.11. Cross-border ownership of patents, 2009-11

As a percentage of countries' total patents

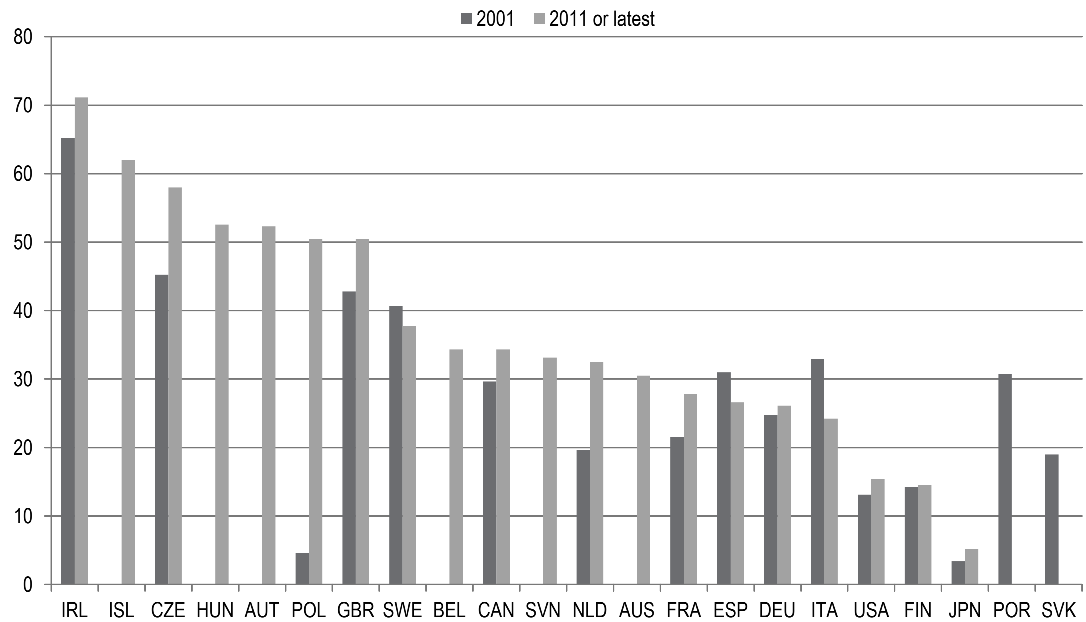


Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

The share of Dutch BERD funded from abroad has remained stable for the past decade at around 15%, just above that of Sweden but somewhat below that of Austria and the United Kingdom (OECD, 2014). A substantial part is funded by the European Commission for participation in the Framework Programme (den Hertog et al., 2012).

Foreign-majority-owned affiliates now account for about a third of BERD, a greater share than a decade ago (Figure 4.12). This suggests that the R&D activities of foreign businesses have increased. However, according to Statistics Netherlands (2012) the shift was the result of a small number of acquisitions of large Dutch-controlled firms by foreign-controlled entities. As such, the increase may reflect important shifts in ownership structure and potentially in decisions about the location of higher-value adding activities such as R&D. Nevertheless, irrespective of ownership, R&D location decisions are subject to global corporate strategies and guided in part by the rise of new markets and of global centres of R&D. Provided it does not lead to substantial diversion of R&D from home, expansion of business sector R&D abroad should not be seen as a national loss. Far from supporting competitiveness, excessive preoccupation with keeping R&D within national borders may ultimately constrain the business sector's ability to enter new markets and shift to new technologies.

Figure 4.12. R&D expenditure of foreign affiliates as a percentage of R&D expenditures of enterprises



Note: The data come from the OECD Foreign Affiliates Database and in some cases are not directly comparable with standard BERD. They are based on the concept of controlling interest, and the statistical test for data is a majority interest (over 50% of shares that carry voting rights on a company's board of management).

Source: OECD (2014), *Main Science and Technology Indicatiors*, Volume 2013/2, OECD, Publishing, doi: 10.1787/msti-v2013-2-en.

The scope of business innovation activity

There are a number of indications that, despite the high overall propensity of Dutch firms to innovate, a smaller share of innovating firms engages in new-to-the-world innovation than in comparator countries. These indications go beyond the low R&D intensity and low share of researchers in R&D personnel observed earlier. They include patterns of collaboration on innovation between firms and other knowledge-producing institutions and between Dutch firms and partners abroad, as well as the types of innovation activity undertaken within Dutch firms and their impact on turnover.

One indication comes from the CIS in the form of the low share of innovating firms that report co-operation with higher education institutions (HEIs) and public research institutes (PRIs) relative to countries with advanced innovation systems (Table 4.9). As the Netherlands scores high on other indicators of university-industry co-operation (the share of university R&D funded by business and co-publications between Dutch universities and industry *abroad*; see below) this suggests the presence of a sizeable group of companies whose innovation activities have a somewhat narrow market scope and may thus derive little benefit from cutting-edge science. Strikingly, it is the larger firms that account for most of the deficit relative to the comparator group. This is in line with the R&D deficit among non-SMEs identified in Figure 4.7. As the R&D and patenting activities of the top ten firms appear very strong in international comparison, the deficit may be due to the performance of a substantial layer of intermediate-sized firms.

Table 4.9. Collaboration between companies and HEIs and companies and PRIs by firm size, 2010

Share of innovative companies, %

	Collaboration with universities or other HEIs				Collaboration with government or public research institutes			
	Firm size bands (numbers of employees)			Total	Firm size bands (numbers of employees)			Total
	10 to 49	*50 to 249*	*250 or more*		*10 to 49*	*50 to 249*	*250 or more*	
Belgium	13%	22%	42%	17%	6%	13%	25%	9%
Denmark	9%	17%	38%	13%	8%	11%	30%	10%
Germany	10%	18%	40%	14%	4%	7%	21%	6%
France	9%	16%	32%	13%	7%	12%	24%	10%
Netherlands	6%	11%	26%	8%	5%	8%	17%	7%
Austria	15%	30%	55%	22%	6%	12%	25%	9%
Finland	23%	40%	68%	30%	17%	30%	60%	23%
Sweden	9%	20%	48%	14%	5%	9%	26%	7%
United Kingdom	3%	4%	5%	3%	2%	2%	2%	2%
Norway	9%	18%	37%	13%	10%	20%	36%	14%
Comparator group average	10%	20%	39%	15%	7%	13%	27%	10%
Netherlands' difference from comparator average	-5%	-8%	-13%	-6%	-2%	-4%	-10%	-3%

Source: OECD, based on Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

A breakdown of companies' collaboration with HEIs and PRIs by industrial sector may shed additional light on the types of firms concerned (Table 4.10). The table shows that the propensity to collaborate on innovation is already at, or above, the comparator group average in Mining and quarrying and in Water supply; sewerage, waste management and remediation activities. However, Dutch enterprises in Agriculture, forestry and fishing, Electricity, gas, steam and air conditioning supply, and in the services sector (particularly Professional, scientific and technical activities; Real estate; and Administrative and support services) were less likely to collaborate with HEIs and PRIs than enterprises in the comparator group. For agriculture in particular this may be due to average firm size and the possibility that the sector has a larger number of firms than in the comparator countries.

Table 4.10. Collaboration between companies and HEIs and companies and PRIs by industrial sector, 2010

Share of innovative companies, %

	Collaboration with universities or other HEIs			Collaboration with government or public research institutes		
NACE sector	Netherlands	Comparator group average	Netherlands' difference from comparator average	Netherlands	Comparator group average	Netherlands' difference from comparator average
Agriculture, forestry and fishing	12%	32%	-19%	5%	23%	-17%
Mining and quarrying	31%	21%	11%	37%	17%	21%
Manufacturing	11%	17%	-6%	8%	11%	-4%
Electricity, gas, steam and air conditioning supply	27%	46%	-19%	12%	24%	-12%
Water supply; sewerage, waste management and remediation activities	25%	22%	3%	18%	18%	0%
Construction	5%	7%	-2%	3%	6%	-3%
Wholesale and retail trade; repair of motor vehicles and motorcycles	4%	8%	-5%	3%	4%	-1%
Transportation and storage	5%	7%	-2%	4%	6%	-2%
Accommodation and food service activities	6%	8%	-2%	0%	2%	-1%
Information and communication	4%	11%	-7%	5%	8%	-3%
Financial and insurance activities	7%	9%	-2%	6%	7%	-1%
Real estate activities	5%	16%	-12%	3%	16%	-13%
Professional, scientific and technical activities	10%	24%	-15%	6%	20%	-14%
Administrative and support service activities	5%	12%	-7%	7%	13%	-6%
All Core NACE activities related to innovation activities (B, C, D, E, G46, H, J58, J61, J62, J63, K and M71)	8%	15%	-6%	7%	10%	-3%

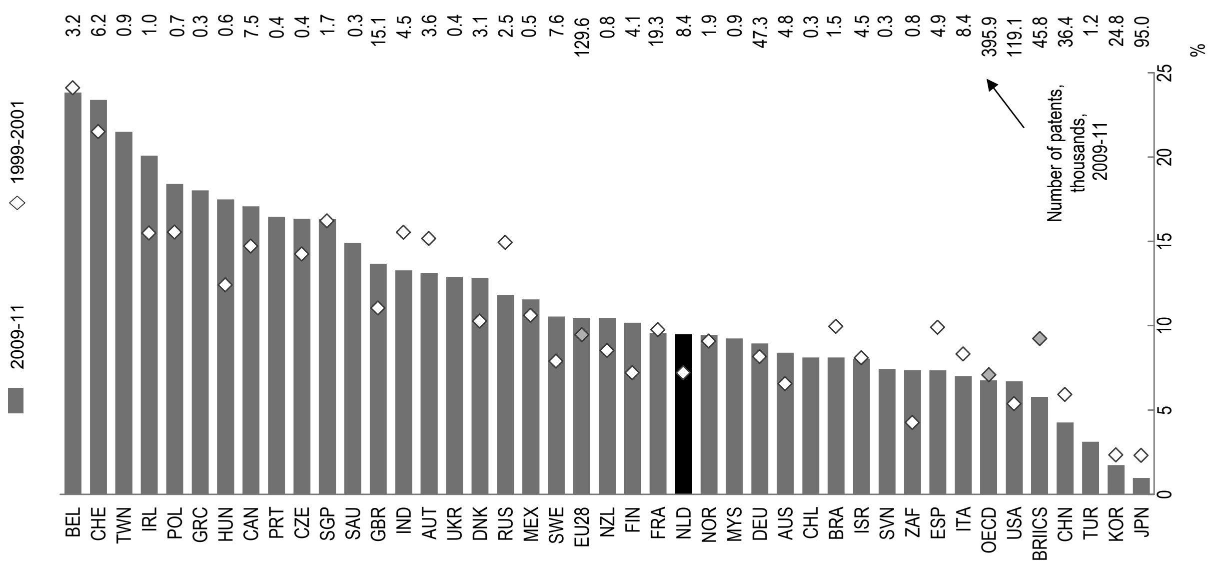
Source: OECD, based on Eurostat (2014), Statistics Database, http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database.

Dutch firms' international collaboration activities provide additional indications. Although the Dutch economy is very internationalised, a smaller share of Dutch innovating firms engage in innovation with international partners than in other advanced countries. The CIS results indicate that a relatively small 22% of innovating Dutch firms collaborate with partners abroad in the course of their innovation activities (compared to 31% for France, 38% for Belgium and 46% for Sweden). This relatively low position is common for both large firms and SMEs (Eurostat, 2014). The incidence of co-inventions, as indicated by patent data, provides a similar pattern, with only moderate performance and a smaller (though increasing) share of internationally co-invented patents than Switzerland, the United Kingdom, Austria, Denmark, Sweden, Finland and France

(Figure 4.13). In addition, the participation of Dutch SMEs in the European Framework Programme is at the EU average, in terms both of the share of SMEs participating and of funds obtained by SMEs (EC, 2013c, pp. 16-17). These findings are at odds with the openness of the Dutch economy and the level of international collaboration of Dutch science in terms of co-publications and participation in the European Framework Programmes. The small share of the business sector that engages in new-to-the-world innovation also contrasts with the strong international patenting performance of the Netherlands (which is *de facto* new-to-the-world). This inconsistency is likely due to the concentration of R&D and patenting among the top companies and to their specialisations. The fact that Dutch patent applications have gone to fewer international patent offices over time may also suggest a focus on specific markets (den Hertog et al., 2012, p. 95).

Figure 4.13. International co-inventions in PCT patents, 1999-2001 and 2009-11

As percentage of the economy's total patents



Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing. doi: 10.1787/sti_scoreboard-2013-en.

Finally, there are some indications that new-to-the-firm innovations are more prevalent in the Netherlands than in the comparator countries. This matters because this type of innovation is dominant in developing rather than advanced systems, where most innovating firms introduce not only innovations that are new-to-the-firm but have accumulated enough capabilities to transition to new-to-the-market innovations.

According to the 2010 CIS, the turnover from innovation is low, at only 73% of the EU average (EC, 2014). This relatively low ranking was also observed in previous CIS (2004, 2006 and 2008), which showed the Netherlands positioned near the median of a slightly different group of countries with advanced innovation systems (OECD, 2013b, p. 133). As noted above, a relatively high share of knowledge-based capital investments goes for the acquisition of machinery and other external knowledge. In the 2008-10 CIS, 37% of innovation expenditure in Dutch firms was devoted to activities other than R&D, compared to 23% in France and around 20% or less in Sweden, Austria, Finland, Norway and Denmark (Eurostat, 2014). Moreover, about 70% of product innovators conduct R&D, a share ahead of France and Germany and similar to Sweden but lower than Finland, Norway and Belgium (where it is closer to or above 80%) (OECD, 2013a, p. 183).

Taken together, these observations suggest a contrast between generally large, R&D-driven and highly internationalised firms and parts of the business sector (primarily intermediate-sized firms with activities in parts of agriculture, utilities, manufacturing and the large services sector), whose innovation activities tend not to extend much beyond the firm or national borders. Even if this reflects the strategic positioning of these Dutch firms in specific economic activities at present, the long-term sustainability of the system would be well served by efforts to extend the scope and ambition of a greater share of business innovators, as is already the case in other countries with advanced systems.

Indeed, the link between R&D and collaboration on innovation, on the one hand, and the greater scope or higher impact of innovations, on the other, has been established empirically in various firm-level studies in the Netherlands using both the CIS and other surveys. Jong and Hulsink (2010) found that small Dutch firms that engaged in more complex types of networking with HEIs, PRIs or government agencies were more likely to have innovation strategies and to employ specialised innovation workers. They were also more likely to introduce innovations that were new-to-the-market (as opposed to new-to-the-firm) and that required new competences. Zhou et al. (2011) found that firms that spent more on R&D, employed highly educated workers and invested in training obtained innovations of greater scope of applicability (new-to-the-market as opposed to new-to-the-firm) and impact (in terms of sales). Uhlaner et al. (2013) found that the sourcing of external knowledge and collaboration with other companies or institutions have direct and cumulative benefits for firm innovation performance and indirectly influence sales growth. Finally, in a study of small firms operating in Dutch high-technology sectors, de Jong and Freel (2010) found that most collaborations were among local firms, though the likelihood of collaborating with more distant organisations increased with the level of R&D expenditures. An econometric analysis by Statistics Netherlands (2010) found that, controlling for other factors, companies performing R&D were more likely to be trading with BRICs (Brazil, the Russian Federation, India, China).

These results should not be interpreted simply as supporting calls for “more R&D”. They do however paint a consistent picture of the need to improve enterprises’ ability to collaborate with universities and research institutes, to strengthen their abilities to collaborate internationally, and to extend the scope of their innovation activities. This will entail more investments in knowledge capital and more intensive innovation efforts, including R&D, and engagement in a greater variety of modes of innovation. These are worthy goals because they can improve the economic impact of a firm’s innovation efforts, improve productivity in the lagging services sector, support an export orientation in emerging markets, and strengthen resilience by bringing about a more balanced portfolio of strong innovators than the current reliance on few large firms.

4.2. Higher education institutions

Higher education is an essential component of the Dutch innovation system, equipping the future labour force with advanced and specialised knowledge and the skills and ability to learn and adopt new skills. Dutch higher education institutions (HEIs) also account for around one-third of all Dutch R&D expenditures, second only to the business sector. The Netherlands' higher education system is composed of academic universities and universities of applied sciences.

There are 13 publicly funded academic universities (Wetenschappelijk Onderwijs, WO) and the Open University.[16] They have a three-fold task: to conduct scientific research, to provide science and research-based teaching, and to disseminate knowledge (which also encompasses valorisation of research). The oldest research university, Leiden University, was founded in 1575, and three more (Groningen, Amsterdam and Utrecht) were founded in the seventeenth century. The rest were founded in the nineteenth and twentieth centuries. Six of the universities are comprehensive (Leiden, Utrecht, Groningen, Nijmegen, and the two universities in Amsterdam) and teach and conduct research in subject fields across the academic spectrum; seven focus on certain areas. Three are universities of technology (Delft, Eindhoven and Twente). A further eight university medical centres treat patients and conduct research, innovation and teaching.

There are 37 universities of applied sciences (UAS, in Dutch, Hogescholen), which offer more practical and professional higher education. The UAS are mainly oriented to teaching that is based on professional practice. Their research capacity is limited but has increased in recent years. In contrast to most OECD countries with binary tertiary education systems, the Netherlands has far more students in the universities of applied sciences (around 65% of tertiary enrolments), compared to a range between 5% in France and 46% in Finland (Weert and Soo (2009), cited in the 2010 Veerman Committee report).

Both types of university obtain direct block grant funding from the Dutch government according to a funding model that includes parameters for teaching and research activities. In the WO, the block grant is divided into a teaching component (41%), a research component (44%) and a component for medical education and research (15%).[17] Of the teaching component, 65% is divided among the WO in proportion to the number of students enrolled and the number of degrees earned, with most of the remainder distributed in the form of a teaching supplement set out in the Higher Education Funding Scheme. Of the research component, 35% is allotted in proportion to the number of PhDs and degrees earned. The remainder is dispensed in the form of an amount for research schools, fixed amounts for each institution, and an amount that is distributed according to the percentages given in the aforementioned scheme (see below for details). In the UAS, 80% of the block grant is distributed in proportion to the number of students enrolled and the number of degrees earned, with the rest allocated on the basis of percentages per institution and for specific policy objectives (Ministry of Education, Culture and Science, 2013). Block grants are paid as lump sums and an institution may spend its allocation at its discretion for the performance of its statutory tasks. In addition to block grants, HEIs receive tuition fees, separate resources for research and revenue from work performed for third parties.[18]

Education activities

University education is of great importance for a country's innovation performance. Over the last few decades, the Dutch tertiary education system has expanded rapidly. The number of first-year students increased by more than half in the last 15 years, reaching 120 000 in 2011. In 2008, nearly 383 000 students were enrolled in UAS and more than 219 000 in WO. In 2012, the numbers rose to 421 000 and nearly 240 000, respectively (Ministry of Education, Culture and Science, 2013). Female students outnumber their male peers in both UAS and WO. However, men far outnumber women in science and engineering: in the UAS, four times as many men as women were newly enrolled in engineering and technology courses in 2011; in the WO, twice as many men as women were newly enrolled in similar courses. Still, the percentage of students enrolled in science, engineering and technology courses in Dutch universities remains relatively low (see Table 3.2).

Since 2002 and the Bologna Declaration guidelines, Dutch tertiary education has been divided into three phases: bachelor's, master's, and doctorate. The minimum course duration for a master's degree is four years, including the three-year bachelor's phase. An academic master's degree programme takes either one, two or three years. The four-year UAS programme leads to a bachelor's degree. Students are free to apply to any university or programme, although many programmes require a specific combination of examination subjects. Some disciplines, e.g. dentistry and medicine, have an admissions quota (Ministry of Education, Culture and Science, 2013).

An international comparison of either UAS or WO study programmes is difficult or impossible because so few have been internationally accredited (Veerman Committee Report (2010), p. 72). The Veerman Report attempted to compare figures on Dutch performance with those of a number of other countries in terms of student selection and/or dropout and success rates. Owing to a wide variation in these respects and in the nature and quality of the data, it is difficult to judge Dutch performance with confidence. However, when compared with the United Kingdom and Germany, student success rates are lower in the Netherlands: 65% in UAS and 68% in WO in 2012, while the rate was 77% in Germany and 82% in the United Kingdom. In engineering and technology courses, success rates were even lower at 58% in both WO and UAS. For science courses in the WO, success rates were just 48% in 2012 (Ministry of Education, Culture and Science, 2013).

A number of reasons can be put forward to explain these comparatively low student success rates. First, student admission systems likely play a role: the Dutch system is by and large open, while many other systems select students and this can influence success rates. Second, the duration of study has traditionally been longer than in some comparator countries, which increases the likelihood of dropout along the way. Finally, there may be issues of teaching quality. Section 5.5 discusses recent government policy changes aimed at improving teaching, particularly in the UAS, an indication that their teaching level is generally regarded as insufficient.

On a more positive note, the number of foreign students studying in Dutch HEIs rose by 82% between 2005 and 2011 (OECD, 2013c), though foreign students still constitute a lower share of total tertiary enrolments (4.9%) than the OECD average (6.9%). Most of the increase occurred in the WO, which have the more internationalised student body. The majority of foreign students in the Netherlands come from Germany, followed by China, Belgium, Bulgaria and Greece (Ministry of Education, Culture and Science, 2013). The number of foreign students has been rising since the early 1990s, a phenomenon that is not unique to the Netherlands. The share of foreign students is in fact increasing in all EU countries that there is increased competition for students at the international level.

Research activities

The higher education sector performed 33% of Dutch R&D in 2011. This is a relatively high share compared with the average for the EU28 (24%) and the OECD (18%). As a percentage of GDP, Dutch expenditure on R&D in HEIs was 0.67% in 2011, compared to an average of 0.46% for the EU28 and of 0.44% for the OECD. The WO perform virtually all of this R&D. The UAS remain minor R&D performers, despite marked increases in R&D spending over recent years (see below).

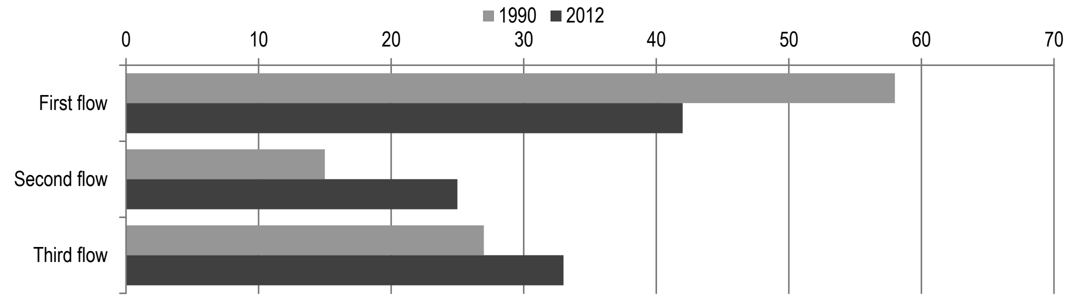
The funding of research in the WO has three mechanisms or "flows". The first flow is the previously described basic funding provided as a block grant (a lump sum) for teaching and research directly by the government. There is no precise financial data for funding flows to Dutch universities; instead, the share of the various funding flows is estimated by the number of scientific personnel they fund. By this measure, the share of first flow funding for university research was on average 42% in 2012, although there is a great deal of variation, with Delft University of Technology having 31% and Tilburg University having 68% of its scientific personnel funded from this source in 2012. The size of the grant is formula-based and, before the reform of the universities' funding system in 2011, it was largely based on student enrolments, number of diplomas and a fixed share. After 2011, as part of the new profiling and valorisation policy, the teaching allocation to academic and professional higher education includes a quality and profile allocation amounting to 7% of the education part of the block grant.[19]

The second flow consists of indirect government funding provided by the Netherlands Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW). NWO distributes most of this funding; the KNAW's much smaller share is mainly intended for university professors. NWO funding is allocated on the basis of evaluation of excellence and competition and is granted to projects, programmes and researcher posts. The average share of this flow was 25% in 2012, with variation ranging from 15% at Delft University of Technology to 37% at Leiden University.

The third flow consists of additional funding for research and education from public and private sources, including government departments, industry, charities, and European and other sources abroad. The share of this source was on average 33% in 2012 and varied among universities, ranging from 53% at Delft University of Technology to 11% at Erasmus University Rotterdam.

The balance between the three funding flows has evolved over time. Figure 4.14 shows that the first flow, i.e. block grant funding, while still the largest funding flow for research in the WO, was previously greater than it is today. It accounted on average for funding 58% of research personnel in the WO in 1990 but only 42% in 2012. The second flow from NWO and KNAW has seen the largest growth, up from 15% of research personnel funding on average in 1990 to 25% in 2012. This signifies a shift towards more competitive project-based funding, a trend in most OECD countries over the last two decades. Over the same period, the third funding flow has increased from an average of 27% of research personnel funding to 33%. Increases in private funding and in funding from EU programmes have been important drivers of this growth.

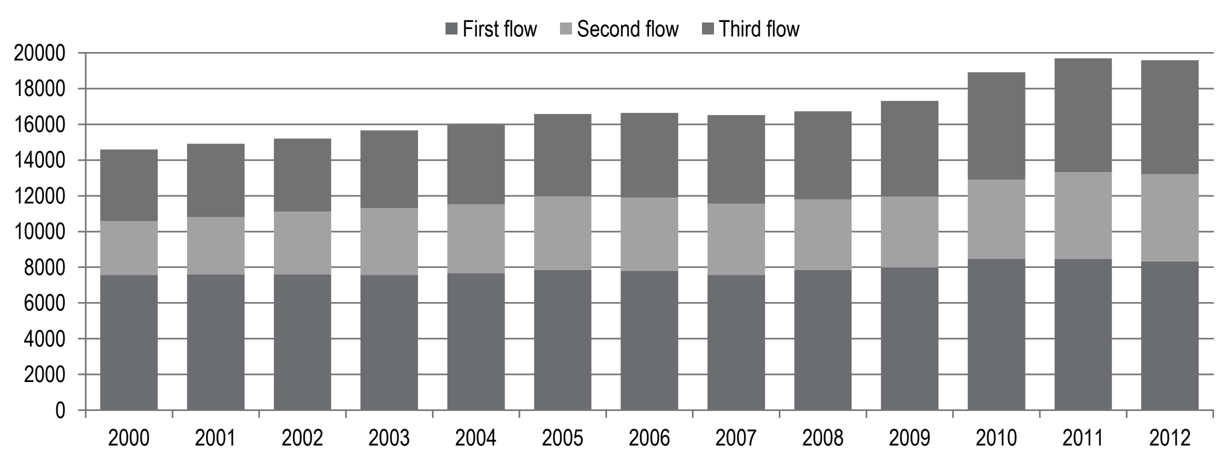
Figure 4.14. Trends in university research funding flows (percentage total)



Source: Ministry of Education, Culture and Science (2013), *Key Figures 2008-2012*, The Hague.

Figure 4.15 shows the implications of these changes for the funding of research personnel in the WO. Most of the increase in research personnel over the past decade – from 14 600 in 2000 to 19 600 in 2012 – has been funded by research council and contract research project funding, while the number of research personnel funded by the block grant has remained relatively stable. At the same time, the ways in which research is organised in the WO has been changing, with a shift towards a range of institutional forms, such as university institutes, research schools, graduate schools and centres of excellence. The Netherlands now has over 100 accredited research schools in which the majority of university research takes place (Chiong Meza, 2012).

Figure 4.15. Research personnel (full-time equivalents) in research universities, by funding flow, 2000-12

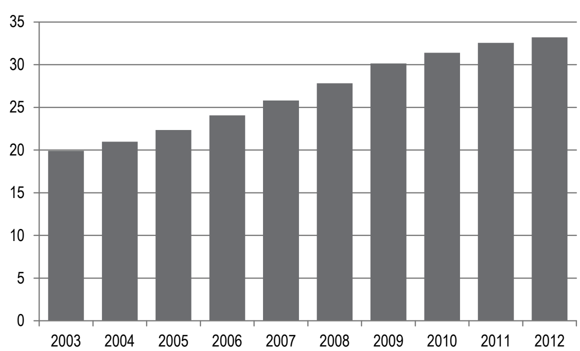


Source: VSNU.

In international comparison, Dutch university research is of very high quality. This is evident from a variety of indicators, including the relative citation rate of Dutch scientific publication output, the citation levels of individual universities, or the citation rates of different scientific fields. As shown in Chapter 3, the Netherlands has the second largest share (after Switzerland) of publications with a high citation impact among domestic publications. Since research universities (including university medical centres) account for close to 90% of Dutch scientific publications, it can be concluded that they perform extraordinarily well as a whole in an international comparison.

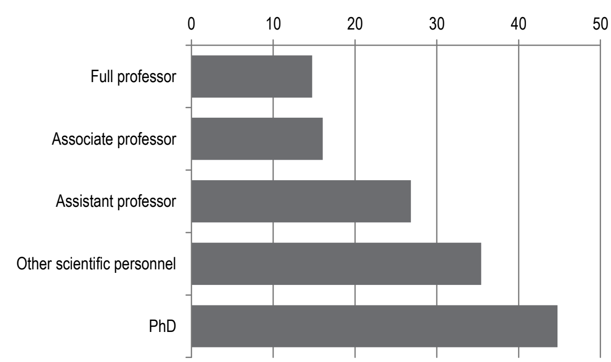
Research in the Netherlands is performed with a high degree of international collaboration. This is attributable both to the scientific excellence of Dutch universities and to the country's relatively small size. Some 48% of Dutch scientific articles were published with an international co-author over the period 2003-11, higher than the OECD+BRIICS[20] average of 42%. Furthermore, 58% of Dutch top-cited articles were co-published with international research institutes, a significantly higher share than the 12% of top-cited articles co-published with domestic institutes (OECD, 2013a). With respect to the international mobility of Dutch researchers from 1996 to 2011, the largest flows are between the Netherlands and the United States, followed by Germany and the United Kingdom. As the net flows between these countries and the Netherlands are positive, the latter is able to attract or attract back researchers at the international level. Figure 4.16 shows the growth in share of foreign scientific personnel in the WO – up from one in five in 2003 to one in three in 2012, or more than 8 000 personnel (in full-time equivalents). Around one-third of these are PhD students and account for around 45% of all PhD students in the Netherlands (Figure 4.17). These figures attest to the openness and high quality of Dutch research universities.

Figure 4.16. Foreign scientific personnel (FTE) in Dutch academic universities as a percentage of total



Source: Rathenau Institute.

Figure 4.17. Foreign scientific personnel (FTE) in Dutch academic universities, by category, and as a percentage of total



Source: Rathenau Institute.

The UAS have a limited research capacity and conduct a very small share of the R&D performed in the HEI sector. It was not part of their original mandate to conduct research and the teachers' education did not provide them with the appropriate capabilities. This started to change in 2001 with the appointment of "lectors", each of whom leads a group of researchers (including lecturers) who carry out research on a particular theme. By 2010, there were around 450 lectors in the system, mostly half-time (HBO-raad, 2010). The task of the UAS is to meet the smaller-scale research and knowledge needs of SMEs, particularly at the regional level. Table 4.11 shows that the necessary resources – both government funds and contract research – have increased in recent years.

Table 4.11. Sources of research funding in the UAS, 2010-12

EUR millions and percentage

	2010		2011		2012	
Government	91.9	73%	107.1	74%	118	71%
Contract research international	4.8	4%	4.1	3%	5.9	4%
Contract research national	29.4	23%	34.4	24%	41.6	25%
Total	126.1	100%	145.6	100%	165.5	100%

Note: The government contribution contains also direct funding from the national research programme on applied research for UAS (NWO-Raak) (roughly 20 %).

The quality of UAS applied research cannot be evaluated in the same way as the more fundamental research of the WO and it is difficult to make international comparisons. Moreover, the system is quite new and still developing. A few national reviews and evaluations of UAS research activities have taken place. They show the importance of this type of research, which has beneficial links to student training and professional practice, and the challenges it faces: the need to upgrade staff qualifications, which are low by international standards[21] and insufficient for significant research activities; the need to increase the number of research staff, which, despite the appointment of lectors, remains very low; the need to invest in research facilities, which are weak, and to facilitate the use of existing facilities in the WO and PRIs; the need to introduce more "focus and mass" in the research activities of each UAS, for example, through profiling and specialisation; and the need to introduce more stable and substantial funding streams in support of UAS research activities (HBO-raad, 2010). Chapter 4 outlines some of the policy measures introduced to tackle these challenges. Still, the impression is that UAS research activities are sub-critical and require further investment if they are to realise their ambition.

Valorisation activities

A third mission of Dutch universities is "valorisation", which has attracted growing attention over the last decade or so. In comparison to other European countries, a "valorisation infrastructure" was established relatively early (Leisyte, 2011). Its existence is not, of course, a guarantee of effective technology transfer and spin-off activities. It has been shown that the existence of formal technology transfer mechanisms is generally positively related with commercialisation but not with academic engagement with industry (Perkmann et al., 2013).

Valorisation has been defined as "the process of creating value from knowledge by making knowledge suitable and/or available for economic and/or societal use and translating that knowledge into competitive products, services, processes and entrepreneurial activity" (Rathenau Institute and STW, 2011). As such, it can have a wide range of manifestations, which can generally be grouped into two categories, i.e. commercialisation and academic engagement. Commercialisation involves the patenting and licensing of inventions and academic entrepreneurship; academic engagement with industry involves multi-directional knowledge-related collaboration via such formal activities as collaborative research, contract research and consulting, and via informal activities such as networking and exchanges at conferences and other forums (Perkmann et al., 2013; Luukkonen and Thomas, 2013). Both activities are important for knowledge transfer and utilisation, but it is harder to obtain information on the many, often informal forms of interaction. Valorisation is therefore difficult to measure and benchmark and valorisation indicators are weakly developed at an international level.[22] Proxy indicators used here are limited to industry funding of university research, university-industry co-publication, and patenting by universities. These are complemented by a qualitative description of organisational arrangements for supporting research commercialisation in universities.

Table 4.12 shows the share of industrial funding of university research in recent years for the Netherlands and some comparator countries. The Netherlands' share increased from 5.2% in 2001 to 8.2% in 2011, and only Belgium and Germany had higher shares among the comparator group. This suggests that university-industry interaction in the Netherlands is relatively strong.

Table 4.12. Share of industry funding of university research, 2000-11

Percentages

	2001	2003	2005	2007	2009	2011
Germany	12.2	12.6	14.1	15.5	14.2	14.0
Belgium	12.7	11.6	10.9	11.1	11.0	10.7
Netherlands	**5.2**	**5.7**	**7.8**	**7.5**	**8.2**	**8.2**
EU28	6.4	6.2	6.4	6.9	6.4	6.6
Total OECD	6.3	5.9	6.1	6.6	6.3	5.9
Finland	6.7	5.8	6.5	7.0	6.4	5.5
Austria				5.7	5.2	5.2
United States	6.5	5.2	5.0	5.5	5.6	4.5
Sweden	5.4	5.3	5.1	4.9	4.5	4.0
Norway	5.8	5.0	4.7	4.0	3.8	4.0
United Kingdom	6.0	5.2	4.6	4.5	3.9	4.0
Denmark	3.0	2.7	2.4	2.1	3.6	3.4
France	3.1	2.7	1.6	1.6	1.8	2.6

Source: OECD (2014), *Main Science and Technology Indicators*, Volume 2013, Issue 2, OECD, Paris, doi: 10.1787/msti-v2013-2-en.

Only a part of knowledge transfers from universities to industry take place through formal contracts involving money transfers. A lot of R&D collaboration takes place in publicly funded research programmes, which may or may not involve direct payment of university research by industry. Other important channels for knowledge transfer are informal interaction at conferences, partnering events and fairs, and training events or through supervision of theses, joint publication, and common research or other facilities. These interactions are not captured by indicators of industry funding of university research.

With this in mind, an internationally comparable indicator that may provide insight on the levels of interaction between universities and firms is the level of university-industry co-publications (expressed as a percentage of the publications linked to a specific university within the country where at least one address referred to is a firm). While there is some bias in this indicator,[23] there is some evidence (e.g. Wong and Singh, 2013) that university-industry co-publications are positively related to universities' technology commercialisation, including patenting, spin-offs, and technology licensing. Table 4.13 compares the share of university-industry collaborative papers across countries using Web of Science-indexed research publications for 2008-11. It shows that 7.2% of Dutch university papers over this period were co-authored with industry, a level surpassed only by Sweden and Denmark. Furthermore, less than half (44%) of these publications were co-authored with domestic firms, a level that is lower than in comparator countries. This could signal a relatively low capacity to perform world-class/new-to-the-world research (as the universities *have* to do) in Dutch industry.[24] However, as universities in the open and advanced Nordic economies have only slightly higher levels of co-authorship with domestic firms than their counterparts in the Netherlands, country size and openness are likely to be important. Moreover, industry co-authored papers of the top 500 universities in the Leiden Ranking 2013 have an average co-authorship with domestic firms of 44%, the same level as Dutch universities (Tijssen, 2013). The relatively low share of co-publications with domestic firms therefore probably signals the high research quality of Dutch research universities and their attractiveness as partners to international firms.

Table 4.13. Share of university-industry* co-publications, by country (2008-11)

Country	Papers co-authored with industry, %	Share of domestic industry,** %
Sweden	8.0	46
Denmark	7.7	52
Netherlands	**7.2**	**44**
Austria	6.8	-
Finland	6.4	51
Norway	6.1	52
United Kingdom	5.2	-
Belgium	5.1	-
United States	5.0	84
Germany	4.9	-
Switzerland	4.9	-
France	4.6	-

Table 4.14. Share of university-industry* co-publications, by university (2008-11)

University***	Papers co-authored with industry %
Utrecht University	7.1
Leiden University	7.3
University of Groningen	6.9
Radboud University Nijmegen	6.1
University of Amsterdam	6.1
University of Wageningen	10.1
VU University Amsterdam	6.5
Erasmus University	7.4
Delft University of Technology	14.0
University of Maastricht	7.2
Eindhoven University of Technology	15.6
University of Twente	9.8

Notes:

*Industry is defined as for-profit business companies and excludes organisations primarily active in the clinical health-care sector and the education sector (i.e. hospitals, clinics, private colleges, etc.) (Tijssen, 2012).

**Refers to the share of research publications with a university author's address in a given country and a co-author from industry in the same country (and possibly also in another country) as a percentage of all publications with a university author's address in the given country.

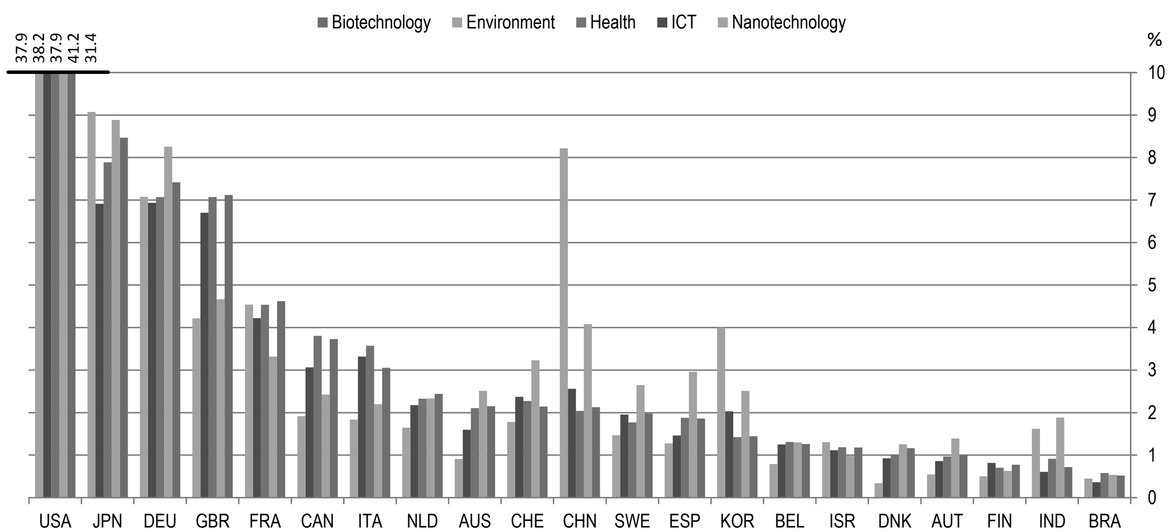
***University of Tilberg is not included, since the data in the table is based on CWTS Leiden Ranking 2013, which includes only the 500 universities worldwide with the largest publication output in the Web of Science database.

Source: R.J.W. Tijssen (2013), "Measuring University-Industry Research Connectivity within and across National Systems of Higher Education", U21 Symposium "National Systems of Higher Education: Criteria for Evaluation", Shanghai, China, 7 November.

In a comparison of individual universities (Table 4.14), the universities of technology and the University of Wageningen (which focuses on food, nutrition and environmental fields) have the highest shares of industry co-authored papers. This is hardly surprising given the nature of their industry-relevant activities, but even the comprehensive universities have quite high shares when compared with the countries in Table 4.13. Furthermore, three universities (Eindhoven, Delft and Wageningen) have a higher share of industry co-authored papers than MIT (8.9%), Stanford (10.0%) or Imperial College London (8.8%) (CWTS Leiden Ranking, 2013). Again, this would seem to suggest that Dutch research universities have comparatively strong links with industry.

As a possible further sign of high research quality and commercial relevance, Figure 4.18 shows that the Netherlands occupies one of the leading positions in the OECD in terms of international patent citations to national non-patent literature (i.e. scientific publications).

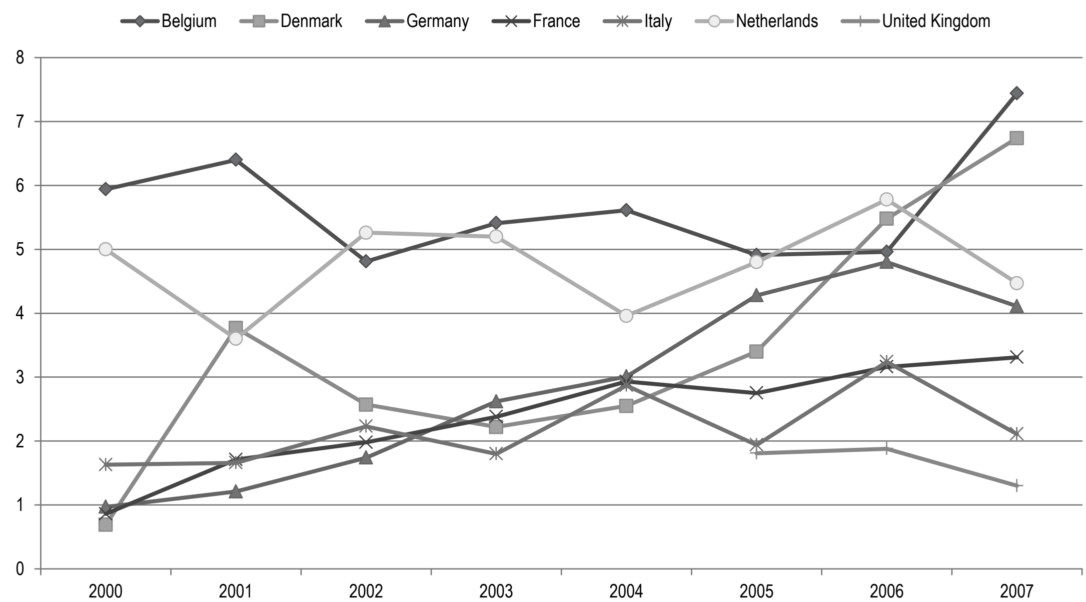
Figure 4.18. Main sources of scientific documents cited in patents, selected technology areas, 2001-11



Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing, doi: 10.1787/sti_scoreboard-2013-en.

Besides academic engagement with industry, commercialisation of research findings (through patenting, licensing and spin-offs) is considered another important valorisation route. Figure 4.19 shows that Dutch universities' patenting performance is good by international standards. Such data should, however, be treated with caution. Patents do not equate to valorisation; they must be exploited, e.g. through licensing or spin-offs, to realise their value. Furthermore, even when they are exploited, patents and other ways to monetise university research capture only (a very small) part of the economic value and social impact of universities. As the direct economic benefits derived by patents (with very few exceptions) are modest, university patents are arguably most useful as steering devices (to align the range of university research that is not patented) and as a conspicuous signal of the economic relevance of university research to potential research collaborators in industry.

Figure 4.19. Number of university patents per 1 000 researchers in higher education



Source: www.wti2.nl.

Technology transfer offices (TTOs), which provide support for a wide range of market-oriented valorisation activities, were first established as early as the 1980s in different institutional forms. Today, all research universities have TTOs attached to them. A specific feature of the Netherlands is that universities have promoted spin-off creation through holding companies, which are legally separate but owned by the universities. The first holding company was established by the University of Twente in 1985, followed in 1992 by Maastricht University and the University of Amsterdam. After the Patent Act was passed in 1995, several others followed (Leisyte, 2011). The holding company owns the shares of the university's spin-off companies and it coaches these companies in matters related to intellectual property, taxation and financial matters. The university obtains the dividends from the shares owned by the holding company.

Box 4.2. YES!Delft incubator

YES!Delft describes itself as a high-technology entrepreneurship centre that seeks to build the leading firms of tomorrow. It coaches students, professionals and scientists to take their first steps on the path to becoming an entrepreneur and offers them support to turn their venture into a success. It conducts entrepreneurship forums and training programmes to motivate and help entrepreneurs lay a solid foundation for their company. Furthermore, it provides them with office space and many technical facilities, access to international networks and knowledge sharing to help promising companies grow even further. It also provides counselling on the several stages of the entrepreneurial process, emphasising access to finance. YES!Delft was initiated by Delft University of Technology, the city of Delft and TNO. It is sponsored by the European Union and several private companies.

Source: www.yesdelft.nl.

Knowledge parks can also be important mechanisms for technology transfer and commercialisation. In a report of the Dutch research organisations published in 2003, all but one university had structures, such as an incubator, to support the creation of spin-off companies (Zomer et al., 2010). Many of these support structures were created in the mid-1990s before the major funding initiatives launched in the 2000s. A more recently established incubator, located at the University of Delft, is briefly described in Box 4.2.

In contrast to the WO, where much research is fundamental in nature, knowledge valorisation lies at the heart of UAS applied research activities, which are supposed to be strongly rooted in professional practice. Much of the research funding available to the UAS, e.g. through the RAAK programme (see Section 5.6), is conditional on collaboration with firms, especially SMEs, and with public bodies. At the same time, most of the lectors appointed since 2001 work only part-time for the UAS and are employed elsewhere with a view to encouraging cross-pollination with professional practice (HBO-raad, 2010). New infrastructure investments, such as the RDM Campus in Rotterdam (see Box 4.3), are also designed to nurture close co-operation between teaching, research and valorisation. However, research expenditures in the UAS are still dwarfed by those in the WO.

Box 4.3. Research, Design and Manufacturing (RDM) Campus in Rotterdam

RDM Campus, whose acronym stands for Research, Design and Manufacturing, began operations in 2009 on the initiative of Rotterdam University of Applied Sciences, Albeda College and the Port Authority Rotterdam. Its main objective is to promote knowledge-based economic development by offering a physical location for research and by connecting it with manufacturers' interests. It gathers students, teachers, professors and entrepreneurs together in innovation teams and communities of practice to address concrete practical questions in the fields of construction, mobility, product design, maritime and maintenance. The Campus is located in the shipyard previously used by the Rotterdamsche Droogdok Maatschappij (Rotterdam Dry Dock) Company as an industrial hall of 23 000 m². In view of the Campus's potential for co-operation between business and educational partners, several government subsidies supported the renovation of the old shipyard's facilities.

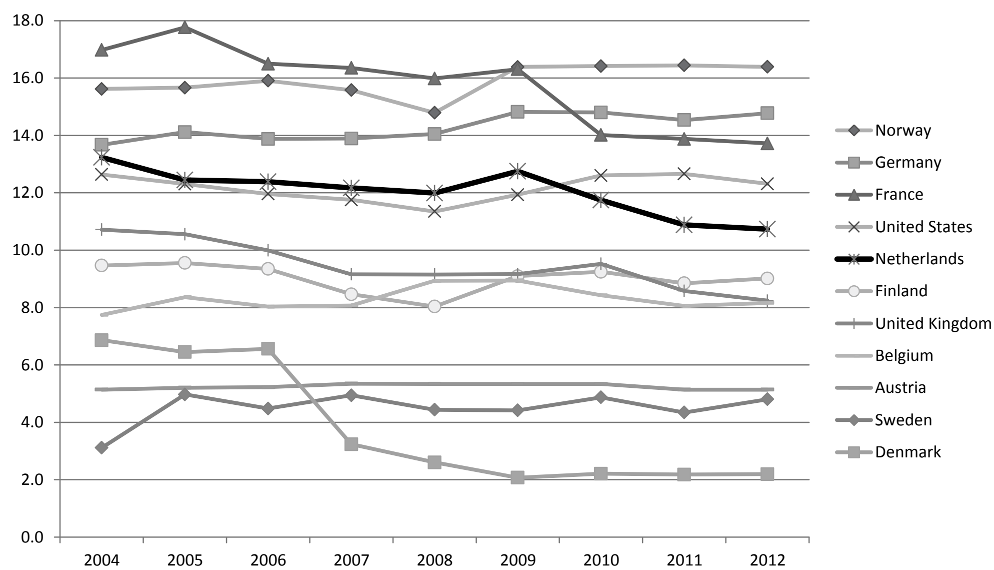
Source: www.rdmcampus.nl and B. Hooijer and G. Muris (2009), "RDM Campus: An innovative learning and working environment in the Port of Rotterdam", working paper.

To conclude, while acknowledging the limitations of the valorisation proxy indicators presented above, taken together, they suggest that Dutch universities are well aligned with the needs of industry and have been for some time. In an international comparison, Dutch universities appear to attract a higher share of their funding from industry than those in most other countries with advanced systems, while co-publications with industry are among the highest in the world. However, CIS evidence presented earlier in this chapter shows that the share of Dutch innovative firms collaborating with universities is low in international comparison. A plausible explanation for the seeming discrepancy could be the fact that the share of industrial funding of university research, which takes place through formal contracts, would be the outcome of a smaller number of larger contracts with large companies, but confirmation would require more detailed data.

4.3. Public research institutes

The R&D expenditures of non-university public research institutes accounted for 10.7% of Dutch GERD in 2012, down from 13.2% in 2004 (Figure 4.20). This places the Netherlands in a middle position *vis-à-vis* a comparator group of advanced economies. As Chapter 3 shows (Figure 3.3), R&D expenditures (in constant USD 2005 prices PPP) have remained largely unchanged in PRIs over this period while increasing in the business sector and universities. This explains the decline of PRIs' share of GERD. As Figure 4.20 shows, the Netherlands is not unique in this respect: France, the United Kingdom and Denmark have also seen declines in the share of GERD performed in PRIs. In Denmark, which has seen the sharpest fall, this is due to the absorption of most Danish PRIs by universities in 2007.

Figure 4.20. Percentage of GERD performed by the government sector, selected countries, 2004-12



Source: OECD (2014), *Main Science and Technology Indicators*, Volume 2013, Issue 2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

For the share of industry funding of research performed in PRIs, the Netherlands leads the comparator countries, with 11.3% of R&D funded by firms (Table 4.15).[25] It has a sizeable applied sciences institute sector geared to performing contract research work for the private sector (see below). Table 4.15 also shows a decline in the share of industry funding, down from 20.6% in 2001. At least part of this decline can probably be attributed to increased competition from universities, which have had an increasing share of their R&D expenditures funded by industry. On another measure of PRI-industry interaction, the share of academic papers co-authored with industry (using Web of Science-indexed research publications in 2008-11) stands at 5.1%, lower than 7.2% of industry co-authored papers emanating from the research university sector (Table 4.13) (Tijssen, 2012, 2013). The explanation may be the fact that several PRIs undertake fundamental research or are in the social sciences and humanities, where the opportunities for industrial collaboration are scant; several also pursue more practical research or research in less high-technology areas, which is unlikely to result in scientific co-publications.

Table 4.15. Share of industry funding of government sector research, 2000-11

Percentages

	2001	2003	2005	2007	2009	2011
Netherlands	**20.6**	**16.4**	**14.6**	**17.1**	**32.4**	**11.3**
Finland	15.2	13.6	12.4	13.7	13.6	11.0
United Kingdom	12.5	8.7	9.9	9.2	8.0	9.7
Norway	10.6	10.1	10.6	10.1	10.3	9.5
Germany	2.3	2.4	9.9	10.8	9.8	9.3
EU28	6.8	5.6	8.3	8.6	8.8	8.1
France	6.3	5.7	7.4	6.5	7.2	7.8
Belgium	12.4	8.9	9.2	9.6	7.7	5.7
Sweden	1.6	1.7	1.5	4.4	5.1	5.2
Austria				9.3	6.0	4.2
Denmark	7.4	1.5	2.1	0.6	0.4	3.4
Total OECD	3.2	2.7	3.6	3.7	3.7	3.4

Source: OECD (2014), *Main Science and Technology Indicatiors*, Volume 2013, Issue 2, OECD Publishing, doi: 10.1787/msti-v2013-2-en.

The data cited above are aggregates that mask the great variety of PRIs. The Dutch PRIs fall into three categories:

– The scientific research institutes that are under the Netherlands Organisation for Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW).

– The government laboratories that conduct research and provide knowledge services to meet the knowledge needs of the state or society.

– The applied research (TO2)26 institutes that provide a range of knowledge-related services intended to meet the knowledge needs of industry. They include TNO (Netherlands Organisation for Applied Scientific Research), the DLO (Agricultural Research Services), and the large technological institutes (GTIs).

Each of these categories is described in more detail below.

Scientific research institutes: NWO and KNAW institutes

The intermediary organisations NWO and KNAW have a number of institutes that perform academically oriented research. NWO has eight institutes in the fields of astronomy, mathematics and computer science, physics, marine sciences, law and criminality, and space research (see Box 4.4). They have four core tasks: to carry out scientific research; to manage major national facilities and to serve as a gateway to international facilities such as CERN for Dutch researchers; to provide research facilities and infrastructure to researchers; and to develop new technologies (Rathenau Institute, 2008). The NWO institutes are independent legal entities with their own managing boards. Together, they employed 1 445 personnel (FTE) in 2012, 58% of whom were researchers. Of the NWO budget of EUR 755 million in 2011, EUR 166 million (22% of the total) was allocated to these institutes. This share has declined steadily over the last decade or so – it stood at around 26% in 2001, as the universities have gained an increasing proportion of the NWO budget from 53% in 2001 to 60% in 2011 (see Section 5.6). Given their roles in co-ordination and facilitation, NWO institutes have close links with Dutch universities. For example, NWO institute researchers can be part-time university lecturers or professors and university researchers can be appointed as temporary guest researchers at the institutes.

Box 4.4. NWO research institutes

ASTRON: Netherlands Institute for Radio Astronomy: Founded in 1949, ASTRON seeks to make discoveries in the field of radio astronomy through the development and operation of word-class equipment and facilities. It also introduces its technologies to the market by developing hardware and software prototypes and products. ASTRON received EUR 31 million in basic funding from NWO in 2011 and employed 112 researchers (FTE) in 2012. Website: www.astron.nl.

CWI: Centre for Mathematics and Computer Science: CWI is the national research institute for mathematics and computer science. The institute was founded in 1946 and is located at Amsterdam's Science Park. It contributes to solutions in a wide range of fields such as energy, health care, climate, communications, mobility and safety. CWI received EUR 18 million in basic funding from NWO in 2011 and employed 154 researchers (FTE) in 2012. Website: www.cwi.nl.

FOM: Foundation for Fundamental Research on Matter: There are three FOM institutes: AMOLF (Institute for Atomic and Molecular Physics), DIFFER (Dutch Institute for Fundamental Energy Research) and Nikhef (National Institute for Subatomic Physics). AMOLF conducts fundamental research in the fields of nanophotonics, solar cells and biomolecular systems. DIFFER focuses on sustainable energy: its generation through nuclear fusion and its storage in the form of solar fuels. Nikhef research centres on particle and astroparticle physics. Together, the FOM institutes received EUR 62 million in basic funding from NWO in 2011 and employed 291 researchers (FTE) in 2012. Websites: www.amolf.nl; www.differ.nl; www.nikhef.nl.

NIOZ: Royal Netherlands Institute for Sea Research: NIOZ conducts marine research in Dutch and overseas waters. Its research areas include biology, physics, chemistry and geology. Its origin goes back to 1876, making it is one of the oldest oceanographic research institutes in Europe. NIOZ received EUR 30 million in basic funding from NWO in 2011 and employed 145 researchers (FTE) in 2012. Website: www.nioz.nl.

NSCR: Netherlands Institute for the Study of Crime and Law Enforcement: NSCR carries out fundamental research into crime and law enforcement. It has three main complementary themes: mobility and the distribution of crime; citizens and the criminal justice system; and life course, crime and interventions. NCSR received EUR 3 million in basic funding from NWO in 2011 and employed 26 researchers (FTE) in 2012. Website: www.nscr.nl.

SRON: Netherlands Institute for Space Research: Founded in 1983, SRON aims to carry out and communicate research regarding astrophysics, the Earth, planets and exoplanets. It also develops new technologies for satellite instruments, health care and food-quality monitoring. SRON received EUR 22 million in basic funding from NWO in 2011 and employed 113 researchers (FTE) in 2012. Website: www.sron.nl.

Source: NWO website: www.nwo.nl.

As in the case of universities, a major output of NWO institutes is scientific publications, many of them co-published with international partners. In 2012, 1 174 scientific publications in the Thomson Reuters/CWTS Web of Science could be assigned to NWO institutes and their 2008-11 citation impact factor stood at 1.62 (where 1.0 is the global mean), a level slightly above that of the Dutch research universities as a whole.[27] These figures confirm the scientific excellence of the NWO institutes.

KNAW has 18 institutes in the fields of humanities and social sciences and life sciences. It also has institutes dedicated to science and technology assessment (see Table 4.16 for a full list of KNAW institutes and headline data). KNAW institutes have three core tasks: to undertake outstanding scientific research; to manage and provide access to unique scientific collections; and to provide services for science and society more generally (Rathenau Institute, 2008). Together, they employed 1 138 personnel in 2011, 60% of whom were researchers. In contrast to NWO, virtually the entire KNAW budget goes to KNAW institutes: in 2011, they accounted for 88% of KNAW's expenditures, up from 75% in 2001. This equates to institute expenditures of EUR 124 million in 2012 compared to EUR 63 million in 2001, i.e. an almost doubling of expenditures over a decade or so. Over the same period, direct block grant funding (flow 1) from the Ministry of Education, Culture and Science increased only moderately, from EUR 75 million (77% of KNAW's total income) in 2001 to EUR 94 million in 2012 (62% of total income). The relatively large increases in KNAW institute expenditures are therefore the product of their success in attracting third-party funding in the form of indirect (flow 2) and contract (flow 3) funding: KNAW's third-party funding rose from EUR 14 million in 2001 to EUR 48 million in 2012, virtually all of which is spent in the institutes.

Table 4.16. Main figures for the KNAW Institutes (2012)

KNAW institutes	Budget (EUR millions)	Personnel (FTE)	Research capacity (FTE)	Scientific publications	PhD theses
Total	109.9	1138.3	687.4	1713	74
Humanities and social sciences	42.8	454.9	171.5	642	23
Data Archiving & Networked Services (DANS)	4.4	45.8	4.6	24	0
Fryske Akademy	1.6	38.7	23.2	51	2
Huygens Institute	7.3	77	51.1	98	2
International Institute of Social History (IISG)	8.4	101.4	12.5	133	3
Royal Netherlands Institute of Southeast Asian and Caribbean Studies (KITLV)	3.8	34.3	13.3	88	9
Meertens Institute	4.9	45.1	18.1	97	1
Netherlands Institute for War Documentation (NIOD)	5.2	54.9	21.3	55	1
Netherlands Interuniversity Demographic Institute (NIDI)	3.7	41	26	81	4
Netherlands Institute for Advanced Studies (NIAS)	3.0	13.5	-	-	-
e-Humanities Group	0.4	3.2	1.4	15	1
Life sciences	60.8	630.7	498.0	1035	51
Fungal Biodiversity Centre (CBS)	6.9	63.2	52.2	134	4
Hubrecht Institute	18.5	198.2	132.9	129	7
Interuniversity Cardiology Institute of the Netherlands (ICIN)	6.1	60.3	75.1	363	19
Netherlands Institute of Ecology (NIOO)	12.6	128.1	116.3	210	15
Netherlands Institute for Neuroscience (NIN)	16.1	178.9	121.5	199	6
Spinoza Centre for Neuro-imaging	0.6	2	-	-	-
Other	6.3	52.7	17.9	36	0
Rathenau Institute	5.1	50.4	17.9	36	0
Waddenacademy	1.2	2.3	0.0	0	0

Source: Rathenau Institute, based on KNAW annual financial accounts and KNAW 2012 annual report.

The various KNAW institutes have different histories but all were set up to fulfil a scientific and/or public need for knowledge and/or for the consolidation of collections. Many of the collections are world-famous and have enabled outstanding research. This can be seen in the quality of their scientific publications: in 2012, 761 scientific publications in the Thomson Reuters/CWTS Web of Science could be assigned to the KNAW institutes and their 2008-11 citation impact factor stood at 1.65 (where 1.0 is the global mean), a level above that of the Dutch research universities as a whole.[28]

Recent years have seen numerous changes in the institutes' organisation in order to create more scope for scientific innovation and the exploration of new avenues of research. This has resulted in the merging or closure of a number of institutes, as well as the establishment of some new ones (Ministry of Education, Culture and Science, 2012). The institutes co-operate with universities on joint research programmes. Their researchers can be appointed to endowed chairs or have part-time appointments as professors at universities. Moreover, KNAW institutes are housed in the vicinity of Dutch universities to encourage institute staff to interact with university researchers and students.

All in all, both NWO and KNAW institutes have an obvious function in the innovation system. They provide research facilities and/or collections for use by researchers, both within and outside these institutes, and contribute to university activities by part-time appointments or more teaching-free research periods for university personnel. Overall, they are well connected with the university sector and subject to regular evaluation exercises similar to those of Dutch universities (see Section 5.6). Bibliometric analysis shows that they conduct outstanding research. In conclusion, they complement the universities and help to maintain institutional variety in the Dutch research system.

Government laboratories

Government laboratories are typically under ministries and their function is to carry out research or to pool research-based knowledge to meet the knowledge needs of the state or wider society. The heterogeneous nature of this category of PRIs is evident in the list of institutes in Box 4.5.

Applied research institutes

The applied research institutes constitute the largest part of the PRI sector and carry out a substantial part of the applied research performed in the Netherlands. The six institutes are the Netherlands Organisation for Applied Scientific Research (TNO); the Agricultural Research Service (DLO); and four large technological institutes (GTIs): the National Aerospace Laboratory (NLR); the Energy Centre of the Netherlands (ECN); Deltares; and the Maritime Research Institute of the Netherlands (MARIN). Each is described in more detail below. Since 2010, the six institutes have worked together in a federation called TO2. Their stated objective is to serve the needs of government departments (part of this research falls under statutory tasks), search for solutions to societal problems, and strengthen innovativeness in the business community. They also manage strategic research facilities, some of which are unique to the Netherlands and internationally (Ministry of Economic Affairs, 2013).

Box 4.5. Government laboratories

The *Ministry of Justice and Security* is responsible for two centres: the Scientific Research and Documentation Centre (WODC), which conducts research on the criminal justice system, commissions research, and has an advisory and knowledge dissemination role; and the Netherlands Forensic Institute (NFI), which conducts forensic research and is a centre of expertise. The annual research expenditure of these two institutes is of the order of EUR 20 million.

The *Ministry of Education, Culture and Science* has a number of cultural institutes with a research function, e.g. the National Service for Cultural Heritage (RCE) and the Netherlands Institute for Art History (RKD). Their annual research expenditure is estimated at EUR 10 million.

The *Ministry of Infrastructure and the Environment* has the Netherlands Environmental Assessment Agency (PBL), which was created by the merger of the agencies formerly responsible for research on spatial planning and the environment. The major function of the PBL is to pool knowledge of relevance to policy, and to conduct strategic policy analyses on the environment, natural habitats and spatial planning. Although this institute is part of the ministry, other ministries may commission studies from the PBL. The annual research budget of the PBL is EUR 30-40 million. The Ministry of Infrastructure and the Environment has a further three research institutions: the Royal Netherlands Meteorological Institute (KNMI), a national institute that studies the weather, climate and seismology, with an annual research budget of EUR 10-15 million; four Rijkswaterstaat centres of excellence on water, transport and infrastructure, construction, and ICT and data management; and the Netherlands Institute for Transport Policy Analysis (KiM), with an annual research budget of approximately EUR 4 million.

The *Ministry of Economic Affairs* has two agencies, Statistics Netherlands and the Netherlands Bureau for Economic Policy Analysis (CPB). They are not primarily research institutes, but conduct studies or research to a small extent. Out of the CPB's annual budget of around EUR 13 million, only part is spent on research; Statistics Netherlands has limited activities in terms of research.

The *Ministry of Health, Welfare and Sport* has the National Institute of Public Health and the Environment and the Netherlands Institute of Social Research, both of which have a key research role. Their annual budgets are EUR 200 million and EUR 8.5 million, respectively.

Note: all budget figures are for 2007.

Source: Rathenau Institute (2008).

Table 4.17 provides various headline statistics on the applied research institutes that draw attention to the diversity of the sector. They were typically founded before the Second World War[29] and differ markedly in their size (in terms of turnover and staff numbers), in their levels of government funding, and in their historical trajectories. They cover a wide variety of research areas and industries, each with its specific needs and challenges. Together, they employ around 8 500 people and in 2012 had a turnover of almost EUR 1.3 billion. As a whole, government contributions in the form of direct block grant funding accounted for about one-third of turnover in 2012, though there is significant variation across institutes. For example, just 11-12% of the turnover of Deltares and MARIN came through direct government funding while this figure was around 40% for DLO. The theoretical rationales for direct government funding of this sort are outlined in Box 4.6.

Table 4.17. Headline data for applied research institutes, 2012

Institute	Total income (2012, EUR millions)	Government direct funding (2012, EUR millions)	Workforce (2012)
TNO	587	192	3 409
DLO	343	137	2 879
GTIs	358	104	2 211
Total	**1288**	**433**	**8 499**

Source: Rathenau Institute. Workforce data come from Ministry of Economic Affairs (2013), "Our Vision for Applied Research" (in Dutch).

Box 4.6. Rationales for direct government funding of the TO2 applied research institutes

Market failure and the public interest. The TO2 institutes invest in precompetitive knowledge issues that receive insufficient attention from the business sector. The same is true for large-scale research facilities housed at the institutes, which are often expensive to run and cannot be financed from routine exploitation.

Scale and synergy. The TO2 institutes focus on the development and/or application of knowledge for the benefit of society and government. These objectives can be pursued thanks to a robust knowledge base that has been built over time. The knowledge developed at the TO2 institutes delivers benefits in terms of scale and synergy that would be lost if the research was scattered across many different organisations.

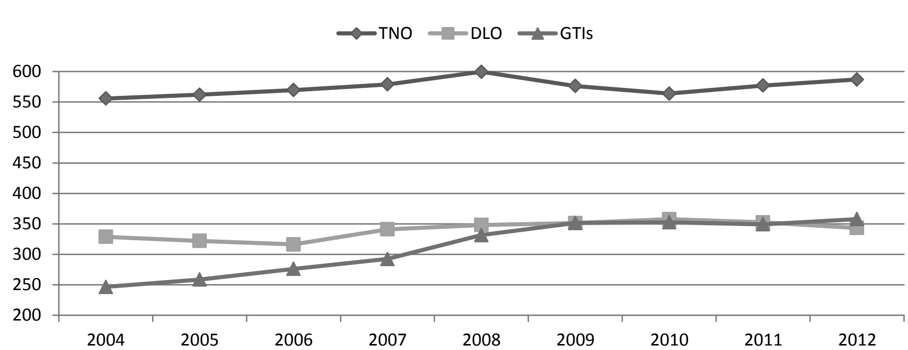
Independence and reputation. The independent status and reputation of the TO2 institutes is of crucial importance, particularly in societally relevant research, where the findings are not open to discussion and must be made directly accessible to government agencies. As the institutes serve the public interest, they are non-profit-making.

Source: Ministry of Economic Affairs (2013), "Our Vision for Applied Research" (in Dutch).

Much of the decline in the PRIs' share of GERD can be explained by the relatively flat rise in income of the TO2 institutes over the last decade or so. Figure 4.21 shows that 2012 income levels in both TNO and DLO are only slightly higher than in 2004 (for TNO, moving from EUR 556 million in 2004 to EUR 587 million in 2012; for DLO, from EUR 329 million to EUR 343 million). These figures point to a decrease in income in real terms and workforces have shrunk in both institutes. As Figure 4.21 shows, the situation is different in the GTIs, whose income has grown from EUR 247 million in 2004 to EUR 358 million in 2012.[30] Given their variety, each of the applied research institutes is discussed separately below.

Figure 4.21. Income of TO2 institutes, 2004-12

EUR millions



Source: Rathenau Institute, based on consolidated financial accounts of TNO and ECN and data provided directly by GTIs and DLO.

Netherlands Organisation for Applied Scientific Research (TNO)

TNO is the largest Dutch research organisation. It has around 3 400 employees and had revenues of EUR 587 million in 2012. It was founded in 1932 to enable business and government to apply knowledge. It is headquartered in Delft but has several other locations around the Netherlands, including The Hague, Rijswijk, Leiden, Groningen, Apeldoorn, Helmond, Hoofddorp, Soesterberg, Utrecht, Den Helder, Zeist, Enschede and Eindhoven. It also has two international branch offices in Qatar and Aruba. TNO is regulated by public law, but is independent: it is not part of any government body, university or company (see Box 4.7 for a short history). As such, TNO is an unusual organisation; its closest international analogues are the German Fraunhofer institutes and the Technical Research Centre of Finland (VTT). Like these German and Finnish counterparts, it aims to support the innovative capacity of companies and to apply scientific knowledge in contract and collaborative research with companies, sometimes in collaboration with universities.

Box 4.7. The changing organisation and presentation of TNO: a short history

TNO was founded by the Dutch government in the early 1930s to support the industrial development of the Netherlands through applied research and technical support. Over time the scope of the organisation broadened to include not only industrial research but also research on defence, food and health. Each of these fields was governed by a separate and relatively autonomous research organisation. These four organisations together shaped TNO as a rather loose federation under a central administrative umbrella. Near the end of the 1970s the need was felt to bring these research fields under a single strategic and operational management. In 1980 the four research organisations and the central organisation were brought together in a new organisation, TNO, under a single Board of Management appointed by the Dutch government.

This model was laid down in the revised TNO Act (1985) which states the goal of the TNO: "to serve [the] public interest and the specific interests of society through the effective contribution of applied technical and scientific research and related social scientific and other applied research". The Act states that TNO undertakes the following activities to attain this goal: applied research, initiated by TNO or commissioned by customers; making research results accessible and transferring these to users by giving information and advice and by supporting user activities aimed at practical applications; co-operation in the field of applied research with other research organisations; contributing to the co-ordination of applied research in the Netherlands and to international co-operation in applied research; and activities assigned by law or "order in council".

By 2000, TNO was composed of 15 institutes. In 2005, these were merged into five core areas, each of which consisted of a number of business units and centres of expertise (there were 28 business units and 21 centres of expertise in all in 2007). These five core areas accounted for about three-quarters of all TNO activities (the figures in brackets show the distribution of turnover for these five areas): TNO Quality of Life (22%); TNO Defence and Security (25%); TNO Industry and Technology (26%); TNO Built Environment and Geosciences (20%); and TNO Information and Communication Technology (8%) (Rathenau Institute, 2008). TNO was again reorganised in 2011 around a matrix management structure that implements projects under seven themes: Healthy Living; Industrial Innovation; Defence, Safety and Security; Energy; Transport and Mobility; Built Environment; and Information Society. The distribution of TNO turnover by theme is shown in Table 4.18.

The pressure for much of this frequent reorganisation over the past decade or so can be ascribed in part to political calls for reform, which has meant that TNO has had to be flexible in the way it organises and presents itself. Such calls are far from unique to the Netherlands, but the sheer size and complexity of TNO make it a larger target than most, as TNO is the fourth largest RTO (research and technology organisation) in Europe. With the introduction of the national top sectors policy, which has major implications for TNO and the other applied research institutes (see Section 5.6), further organisational changes can be anticipated in the coming years.

Sources: Leijten, J. (2007), "The future of RTOs: a few likely scenarios", in European Commission (2007), *The Future of Key Research Actors in the European Research Area*, EU 22962 EN, Luxembourg: Office for Official Publications of the European Communities; Rathenau Institute (2008); and the TNO website (www.tno.nl).

In common with the other TO2 institutes, TNO receives direct funding from the Dutch government for around one-third of its income. In 2011, the Ministry of Economic Affairs assumed the lead in providing this funding; previously, the Ministry of Education, Culture and Science had taken the lead. The arrangements for assigning and distributing direct funding changed in 2007 to involve more demand-driven funding and steering by the government (see Chapter 4). This has led to the creation of different categories of direct funding. One is funding of "knowledge as an asset", which roughly equates to basic funding and is made up of two components, "knowledge as an asset within themes" (which is driven by demand from the Ministry of Economic Affairs and amounted to EUR 49 million in 2012) and "knowledge as an asset across themes" (which covers R&D not directly linked to demand from society or government departments and amounted to EUR 23 million in 2012). The second is "policy and applied research", which is described as targeted funding and is provided by several ministries besides Ministry of Economic Affairs. It amounted to almost EUR 120 million in 2012 (Table 4.19). Thus, taken together, direct funding of TNO by the Dutch government totalled EUR 192 million in 2012.

Table 4.18. TNO turnover by theme, 2012
Percentages of total

Theme / area of expertise	% turnover
Defence, Safety and Security	17
Industrial Innovation	15
Healthy Living	13
Energy	9
Built Environment	8
Information Society	8
Transport and Mobility	7
Other	22

Source: Rathenau Institute, based on TNO accounts 2012.

Table 4.19. TNO income "Policy and applied research funding", by ministry, 2012

Ministry	Targeted funding, EUR millions
Ministry of Defence	41
Ministry of Economic Affairs	37
Ministry of Infrastructure and the Environment	19
Ministry of Social Affairs and Employment	11
Ministry of Health, Welfare and Sport	7
Ministry of Interior	5
Total	**120**

Source: Rathenau Institute, based on TNO accounts 2012.

The other two-thirds of TNO's income come from the market. It can be broken down into several components (Figure 4.22). Assignments funded by the Dutch public sector generated an income of EUR 100 million in 2012, representing 17% of total annual income. Income from the private sector can be divided between domestic and foreign sources. In 2012, contracts with Dutch firms generated an income of EUR 142 million (24% of total annual income), while contracts with foreign firms generated an income of EUR 110 million (19% of total annual income). Figure 4.23 shows how these private-sector income streams have evolved over the last decade or so. Since 2004, income from foreign firms has increased steadily while income from Dutch firms fell with the onset of the 2008 financial crisis and has yet to return to pre-crisis levels. Finally, income from international assignments have increased over time and stood at EUR 43 million in 2012 (7% of total annual income). This reflects TNO's success in the EU Framework Programmes.

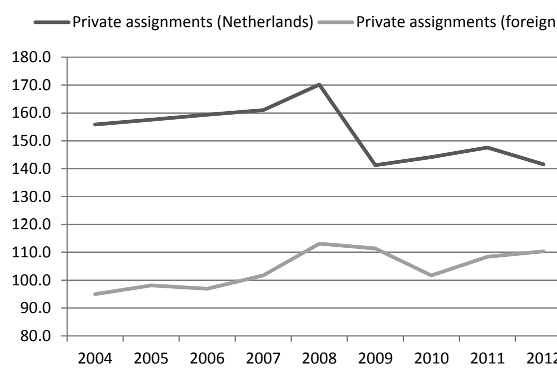
Figure 4.22. TNO income, by source of funding, 2004 and 2012

Percentages of total

Source: Rathenau Institute, based on consolidated financial accounts of TNO.

Figure 4.23. Trends in TNO income from private contracts, domestic and foreign, 2004-12

EUR millions



Source: Rathenau Institute, based on consolidated financial accounts of TNO.

Strong links with firms are an essential part of TNO's *raison d'être*. While the data presented above show that 43% of TNO's income came from private-sector sources in 2012, a large majority (even of domestic industry funding) comes from large firms. Nevertheless, many contracts are with SMEs (around 2 000 in 2011), and various tools are used to reach a wider group of firms, often in co-operation with other government agencies and/or company associations. Together, TNO claims that these activities mean that it reaches some 10 000 SMEs a year. Another part of TNO's market-oriented strategy concerns valorisation. Since the 1980s, pioneering applied research developed by TNO that has not been immediately taken up by the business sector has been spun off to companies for commercial exploitation. This is often done in alliance with other partners to get innovations out into the market more quickly (TNO, 2013). The companies are placed in a holding company, TNO Companies, which is independent of TNO in both the financial and legal sense but in which TNO is the shareholder. TNO Companies currently has around 90 companies, with a regular flow of new companies entering and established companies being sold off. Another valorisation channel is focused on intellectual property. TNO typically makes more than 100 patent applications a year and has many licence agreements with firms. It uses its IP portfolio to attract investors in start-ups.

TNO also works with the universities, most visibly in dedicated "knowledge centres", of which there were 18 in 2011. Furthermore, dozens of TNO's researchers work as part-time professors at a number of universities. These include "lectors" working in the UAS (see above). TNO also participates in the RAAK scheme for supporting applied research activities in the UAS (see Section 5.6). This kind of collaboration seeks to further strengthen the relationship between TNO and the SME sector. TNO researchers also publish in the academic literature. In 2012, 717 scientific publications in the Thomson Reuters/CWTS Web of Science could be assigned to TNO and their 2008-11 citation impact factor stood at 1.23 (where 1.0 is the global mean), a level below that of the Dutch research universities as a whole.[31]

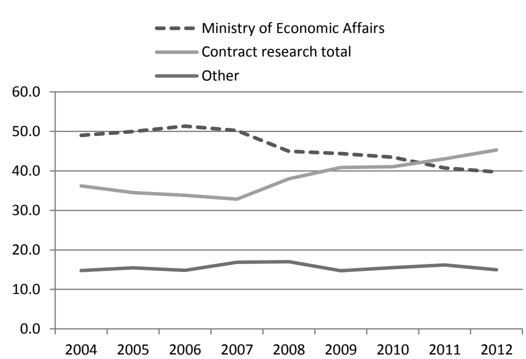
DLO Foundation

The DLO Foundation is a collection of nine research institutes[32] that perform agricultural research. Formerly a much larger number of institutes under the control of the former Ministry of Agriculture, Nature and Food Quality, the institutes were privatised in the second half of the 1990s under the umbrella of the DLO and entered into an alliance with Wageningen Agricultural University to create the Wageningen University and Research Centre (WUR). The DLO and the university remain separate legal entities under these arrangements but work closely together on application-oriented and field-based research. DLO has a workforce of just under 3 000, making it the second largest applied research performer in the Netherlands after TNO.

DLO's annual turnover of EUR 343 million in 2012 is second only to that of TNO. About 40% of DLO's budget is basic (direct) funding provided by the Ministry of Economic Affairs and is directed towards four areas (Rathenau Institute, 2008): fundamental research, which focuses on the medium-term needs of the Ministry of Economic Affairs, non-governmental organisations, other governmental agencies and Wageningen University; research to support policy making, with a focus on current policy issues; statutory research tasks, including research on current policy issues and meeting the requirements of legal frameworks; and other research projects.

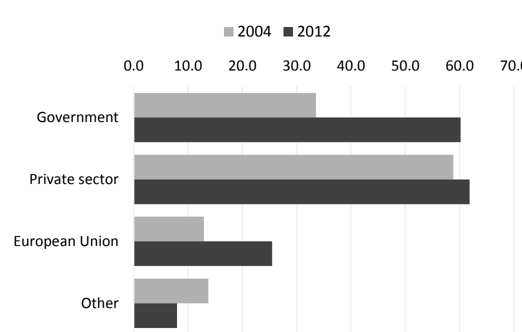
As Figure 4.24 shows, the proportion of direct funding from the Ministry of Economic Affairs has fallen in recent years. As late as 2007, direct funding accounted for around half of DLO's revenues. The decline has been offset by an increase in contract research, which now constitutes around 45% of revenues. Figure 4.25 provides a breakdown of contract research income. While the private sector is the largest source of such income (EUR 62 million in 2012), its level has increased hardly at all over the last decade (EUR 59 million in 2004) and it now makes up less than 40% of all contract research income. The growth in contract income is in fact driven by large increases in funding from government sources (rising from EUR 34 million in 2004 to EUR 60 million in 2012) and from the EU (from EUR 13 million in 2004 to EUR 26 million in 2012). These shifts are symptomatic of the Dutch government's policy to reduce direct funding of the applied research institutes and to increase more competitive project-based funding.

Figure 4.24. DLO income, by source of funding
Percentages of total



Source: Rathenau Institute, based on Wageningen University Research Centre Annual reports.

Figure 4.25. Composition of DLO contract research income, by source of funding
EUR millions



Source: Rathenau Institute, based on Wageningen University Research Centre Annual reports.

Large Technological Institutes (GTIs)

The other four institutes for applied research are known as the Large Technological Institutes (GTIs). They conduct research and related activities in specific areas, as outlined in Box 4.8. They have two important roles: they are centres of technological expertise for companies and government; and they develop technology and make it available to companies and government.

Box 4.8. Main features of the Dutch Large Technological Institutes (GTIs)

Deltares works in the fields of hydrological engineering, integrated water management, geo-engineering, and groundwater management. It aims to provide innovative solutions for flood risk management, regulation of the availability of water and soil resources, delta infrastructure, healthy water and soil systems, and sustainable delta planning. It was established in 2008, with the merger of WL Delft Hydraulics, GeoDelft, and parts of TNO and the Ministry of Transport, Public Works and Water Management. Deltares employs close to 800 people and is based in Delft and Utrecht. With an annual turnover of EUR 111 million in 2012, its contracts and projects are financed both privately and by public research budgets.

The *National Aerospace Laboratory (NLR)* acts as an intermediary between universities and firms, translating scientific knowledge into technological ideas that industry can develop into concrete and competitive products. NLR also provides materials for policy development by the ministries that are responsible for the safety and environmental aspects of air transport. NLR generates around three-quarters of its turnover from paid contracts from the Netherlands and other countries, from governments to aircraft manufacturers, and from civilian to military clients. About half of NLR's industrial activities are carried out on behalf of SMEs. NLR employs more than 600 people. NLR's facilities include wind tunnels, simulators, and laboratory aircraft. Its revenue amounted to EUR 79 million in 2012, with contracts accounting for more than EUR 60 million.

The *Energy Research Centre of the Netherlands (ECN)* performs R&D in the fields of renewable energy (wind, solar and biomass), energy efficiency, environment energy, and engineering and related policy studies. With around 500 staff, ECN leads domestic and international projects in joint efforts with the industry, government authorities, universities and research institutes. It has three offices in the Netherlands (Petten, Amsterdam and Eindhoven) and branches in Belgium and China. ECN had a turnover of EUR 76 million in 2012.

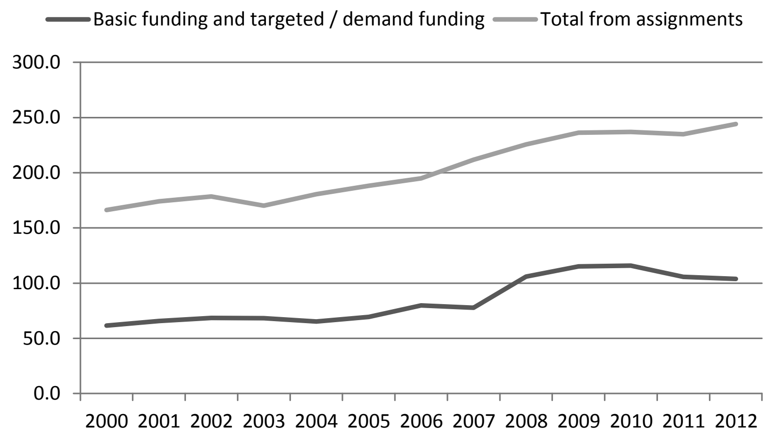
The *Maritime Research Institute Netherlands (MARIN)* provides innovative design solutions and carries out advanced research for the maritime business sector. It conducts research for shipbuilding, offshore technology and ocean engineering and develops software for maritime and mission bridge simulation. MARIN draws upon seven test facilities, has more than 300 employees and a worldwide network of scientists in hydrodynamics and nautical support. More than 80% of its EUR 42 million turnover in 2012 was earned from the commercial worldwide maritime industry. Its customer base includes commercial ship builders, fleet owners, naval architects and offshore drilling companies.

Source: GTI websites.

As with the other TO2 institutes, the GTIs receive basic funding from the Ministry of Economic Affairs. The arrangements for earmarking and allocation are similar to those described above for TNO, i.e. there has been a shift towards greater articulation of government demand and steering of the GTIs' research activities. Other ministries provide targeted funding, another component of the direct funds flowing to the GTIs. Taken together, direct funding of the GTIs stood at EUR 104 million in 2012 (29% of their total annual income of EUR 358 million), down from EUR 116 million in 2010 when this funding constituted 33% of total annual income. As noted above, there is great variety in the share of this funding between the different institutes. Figure 4.26 shows that most of the GTIs' income is acquired on the open market in the form of public and private contracts. The share of such contracts as part of total turnover has remained fairly constant since 2000 and stood at 68% in 2012.

Figure 4.26. GTI income by source of funding

EUR millions



Source: Rathenau Institute, based on information supplied by the GTI.

The GTIs also collaborate with the universities; an example involving NLR is outlined in Box 4.9. Researchers from the GTIs also publish in the scientific literature. For example, in 2012, 171 scientific publications in the Thomson Reuters/CWTS Web of Science could be assigned to Deltares while their 2008-11 citation impact factor stood at 1.35 (where 1.0 is the global mean), a level almost on a par with the Dutch research universities as a whole.[33] The figures for ECN over the same period are: 158 publications in 2012, with a 2008-11 citation impact factor of 2.06, well above the Dutch research universities' average and the more academic NWO and KNAW institutes.

Box 4.9. Collaboration between the National Aerospace Laboratory and universities

The National Aerospace Laboratory (NLR) engages in fundamental research in close collaboration with Dutch universities. In addition to providing internships and opportunities for graduation projects, it has PhD students on its payroll who conduct fundamental research with the universities. It also works with various universities on projects in fundamental and applied research and often acts as an intermediary between academia and industry. External PhD students have regular access to its facilities. The NLR enjoys a special relationship with TU Delft as co-owner of a research plane. The two organisations share its maintenance and management, thus significantly increasing its cost-effectiveness. TU Delft uses it for teaching purposes and fundamental research and the NLR uses it for applied research and operational services. TU Delft and the National Aerospace Laboratory work intensively with the plane at the interface between fundamental and applied research.

Source: Ministry of Economic Affairs (2013), "Our Vision for Applied Research" (in Dutch).

Notes

1. This may partly be explained by the severity of the banking crisis in the Netherlands and may therefore not reflect business evaluations of returns to knowledge investment. Still, the decrease in investment in non-residential physical assets was equally or less severe than in countries in which investment in KBC increased (Denmark, Ireland, Portugal, Luxembourg, Slovenia and the United States).

2. It is not realistic to expect the Netherlands to be a leader in shifting the global knowledge frontier. By many estimates, even in systems as large and advanced as the United States most economic gains come from innovations from elsewhere. The argument here is about the share of new-to-the-world or less ambitious innovators *within* a country.

3. In addition to its potential for shifting the frontier, R&D of course also serves to facilitate national absorptive capacity.

4. An important limitation of the comparison is the fact that it does not capture the position of Dutch firms in global value chains. Given the internationalisation of the Dutch economy, and its proximity to key EU markets and knowledge centres, this may have implications for the R&D location choices of Dutch firms (see below).

5. Alternative calculations of business R&D intensity by firm size class as a share of GDP (not reported here) confirm this pattern and specify that the deficit with respect to the comparator group is greatest in firms with 500 employees or more (i.e. firms in the 250-499 employee size class have as narrow a gap as the SME sector).

6. It would be valuable to know the respective contribution of each explanation as it could point to problems in finer segments of the business sector. This could be the topic of firm-level studies, potentially accounting for other possible explanations.

7. In principle, the low costs relative to other advanced systems, in combination with strong research institutes, would appear to make the Netherlands an attractive location for internationally mobile R&D investment. However, as discussed below, there is little evidence that much additional business R&D has been attracted from abroad in recent years.

8. An alternative (or complementary) explanation may be the fact that R&D personnel are classified by education (den Hertog et al., 2012), rather than by occupation as recommended in the *Frascati Manual* (OECD, 2002: p. 92).

9. 57% of innovating firms in the Netherlands, against 72% in Germany, 70% in Denmark and the United Kingdom, 68% in France, 63% in Finland and Belgium, 62% in Sweden and 60% in Norway.

10. 49% of innovating firms in the Netherlands against, 60% in Denmark, 55% in Germany, Sweden and Austria, 54% in Finland and 53% in the United Kingdom.

11. Scientific and technological problems that require large scale efforts (large research teams, expensive infrastructure etc.) are sometimes said to be ‘indivisible’ as effective solutions cannot be obtained with only fractions of the required resources.

12. In a complementary explanation, den Hertog et al. (2012) find that Dutch international patents are increasingly concentrated over time in fewer technology

classes, a strong indicator of technological specialisation that would also operate in the direction of improving patenting productivity.

13. Not all large corporate R&D spenders choose to make this information public. According to de Heide et al. (2013) 59% of their expenditure took place abroad.

14. The picture emerging from fragmented evidence on the distribution of R&D expenditure across firms of various sizes suggests that the R&D deficit observed in Figure 4.7 is likely due to intermediate-sized firms (larger than SMEs but not in the top ten).

15. Information published separately by Statistics Netherlands (2014) on foreign affiliates according to country of ultimate control suggests that in 2011 about a third of foreign affiliate R&D (data only available for: Mining and quarrying, Industry, Energy, Water supply and waste management, and Construction) was performed by affiliates under Dutch ultimate control.

16. In addition to the university-level organisations, four universities which formerly were not funded by government but were "officially recognised" became "government-funded institutions" that provide teaching focused on theology or humanistic ideals (Chiong Meza, 2012, p. 5).

17. The research universities involved channel this last component of the budget in its entirety to the teaching hospitals.

18. For example, the UAS had revenues of EUR 3.6 billion in 2011, of which EUR 2.5 billion from Ministry of Education, Culture and Science grants, EUR 43 million from other government grants, EUR 675 million from tuition fees and EUR 204 million from contract work.

19. The new system also entails performance agreements made with individual HEIs, which include a strategic plan and targets for improving educational achievements, strengthening of the educational and research profile, and attention to impact and valorisation. These changes are discussed more fully in Section 5.5.

20. BRIICS: Brazil, the Russian Federation, India, Indonesia, China and South Africa.

21. UAS teachers had the lowest level of qualifications in universities of applied science in a recent comparison of ten countries (Weert and Soo, 2009).

22. In a recent study for the Dutch National Valorisation Commission, the Rathenau Institute and STW (2011) concluded that "a combination of quantitative and qualitative data is needed to achieve a good assessment. Valorisation cannot be measured through simple counting. The complexity and diversity of the valorisation process mean that an assessment based on a few quantitative indicators makes little sense. This also means that a simple comparison of valorisation performance is impossible."

23. University-industry co-publications are more usual in scientific fields with links to high technology. Electrical engineering and telecommunications, energy science and technology, instruments and instrumentation, civil engineering and construction, basic medical sciences, computer sciences, mechanical engineering and aerospace are fields for which, at a minimum, 10% of public-sector publications had at least one industry co-author. Public sector here means organisations other than for-profit companies: universities, for-profit organisations in the educational sector, and medical and health-care sector (Tijssen, 2012).

24. Cross-country evidence links the delocalisation of university-industry interaction to the level of business R&D (Azagra-Caro et al., 2013). It may also suggest Dutch firms' preference for collaborating with universities abroad, but the CIS evidence presented above counters this view somewhat, as Dutch firms collaborate less with partners abroad (of all types) than countries in the comparator group.

25. In June 2013 Statistics Netherlands published revised figures for GOVERD for the whole period 1999-2011. These changes are not reflected in internationally comparable OECD statistics. According to these revised figures, 16.8% of the R&D performed in PRIs was funded by industry in 2011.

26. TO2 is the acronym for Toegepast Onderzoek Organisaties (organisations dedicated to applied research).

27. Data from www.wti2.nl.

28. Data from www.wti2.nl.

29. Deltares, founded in 2008, is the product of an amalgamation of GeoDelft (founded in 1934) and WL Hydraulics (founded in 1933).

30. Some care is needed in interpreting these figures, since there has been some shift in the institutional boundaries of the various institutes. For example, Deltares, which was created in 2008, incorporated parts of TNO into its organisation.

31. Data from www.wti2.nl.

32. The institutes are AFSG: Agrotechnology & Food Sciences Group; Alterra in the field of green living environment; ASG: Animal Sciences Group; CIDC: Central Veterinary Institute Lelystad; LEI: Agricultural Economics Research Institute; PRI: Plant Research International; RIKILT: Institute of Food Safety; and Wageningen IMARES: Institute for Marine Resources & Ecosystem Studies.

33. Data from www.wti2.nl.

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Chapter 5

The role of government

This chapter examines public activities that have a bearing on the Dutch innovation system. It begins with an overview of the historical evolution of science, technology and innovation policy in the Netherlands. It then examines the main policy actors and governance arrangements, with particular reference to the top sectors approach. The chapter then reviews current policies under the light of the observations made in earlier chapters and outlines areas in need of dedicated policy attention.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

5.1. STI policy in the Netherlands: An historical overview

The evolution of Dutch science, technology and innovation (STI) policy largely follows broad international trends. At the same time the Netherlands has taken some distinct approaches and has pioneered a number of innovation policy developments. In the recent history of STI policy, the emergence of a new sector-oriented, thematic approach is one example.

The demise of old-style industrial policy and the emergence of technology policy

Innovation policy emerged from the industrial and sectoral policies that were part of the economic policy toolkit of the 1960s and 1970s. The first attempts to develop an explicit innovation policy were primarily oriented towards the supply side, through the use of financial instruments to stimulate R&D. As this was considered insufficient to achieve the desired increase in the international competitiveness of Dutch producers, the intermediary infrastructure was strengthened to foster the dissemination of new technologies and to provide businesses with R&D results that would enable them to develop new innovative products. To this end, policy measures to stimulate the mobility of researchers from academia to private enterprise and to establish a network of regional innovation centres were put in place (Boekholt and den Hertog, 2005).

The decline of traditional industries, such as textiles and shipbuilding, had been addressed by concentration and government-backed attempts to restructure. In 1971, for example, "large parts of the shipbuilding and metal products industries were amalgamated into RSV [the Rijn-Schelde-Verolme shipyard], which received handsome subsidies to develop new lines of production (and slowly close down the old ones" (van Zanden, 1998, p. 47). During the second half of the 1970s and the early 1980s the costs – and lower than expected benefits – of these old-style "defensive" industrial policies became apparent: for example, the RSV went bankrupt in 1983. As a result, the Netherlands, like other industrialised countries, shifted from supporting and restructuring ailing industries towards a more "future-oriented" policy in which technology and related instruments were assigned a key role. In many OECD countries, government support shifted towards the promotion of "key", "pervasive" or "enabling" technologies.[1] In the Netherlands, during the second half of the 1980s, "technology policy" was oriented towards supporting emerging fields of technology rather than particular economic sectors (Velzing, 2013). The emphasis was on promoting R&D; other aspects of innovation tended to receive less attention and remained in the background.

Boekholt and den Hertog (2005) note that innovation policy gained prominence as a separate policy domain through the 1979 *White Paper on Innovation Policy* issued by the Minister for Science. In its wake a number of new – mostly financial – policy instruments were introduced to foster innovation (grants, fiscal measures, risk capital funds). In 1980, the Scientific Council for Government Policy (WRR), in its report, *Industry in the Netherlands: Its Place and Future*, advocated specific investments in sectors of current or emerging strengths (Velzing, 2013). In 1981, an Advisory Council for Industrial Policy (the so-called Wagner Committee) was asked to develop a new, future-oriented industrial policy. This "independent committee was to have a large influence on transforming traditional industrial policy into innovation- and market-oriented policy" (Boekholt and den Hertog, 2005).

In line with the tenets of New Public Management, major changes were made in the organisational set-up and governance of the Netherlands' innovation policy. The Ministry of Economic Affairs began to separate policy making and implementation in 1988. "Agencification", through the establishment of StiPT,[2] made innovation policy delivery more transparent; the Ministry increasingly involved external advisory committees in the assessment of project proposals (Velzing, 2013).

Generic STI policies of the 1990s

In the early 1990s an apparent mismatch between the needs of business firms and the knowledge produced by (public) knowledge suppliers showed the need for better interactions between these two sets of actors (Boekholt and den Hertog, 2005) and measures were taken to improve the interface between them. Networking was facilitated, for example, by a high-performance ICT infrastructure. More advanced risk capital schemes were adopted, and strategic intelligence was upgraded and expanded to meet the increased need for information (Boekholt and den Hertog, 2005). As in other countries, the number of actors involved in the development and delivery of innovation policy – and the need for systemic policies and better co-ordination – increased. In the second half of the 1990s, the Ministry of Economic Affairs sought to encourage co-operation between businesses and knowledge institutions and to provide frameworks and incentives for the latter to become more market-oriented (Velzing, 2013).

According to Boekholt and den Hertog (2005), the predominant stance during most of the 1990s was that science and technology (S&T) policy should be generic, i.e. that government should largely refrain from influencing the allocation of resources, leaving it to industry to decide in which areas to invest. Its appropriateness was however questioned around the turn of the century owing to some perceived shortfalls in Dutch innovation performance. These included a shift towards the "applied" end of research by major R&D performers in the business sector, relatively few (high-technology) spin-offs from Dutch universities and research institutes, and a comparatively weak position in the life sciences and nanotechnology, major emerging areas of S&T (Boekholt and den Hertog, 2005).

In 2002, the Interdepartmental Investigation on Technology Policy (Interdepartementaal Beleid Onderzoek Technologiebeleid – IBO) concluded that "while the overall system is functioning rather well, the large number of instruments causes, among others, ineffectiveness and inefficiency in policy implementation due to overlaps and a lack of transparency" (OECD, 2005, referring to IBO, 2002). "In addition it was suggested that there should be a shift in emphasis from specific instruments to generic instruments and from "near-to-the-market" towards more fundamental research and that co-operation among firms and between firms and research institutes should be stimulated." (OECD, 2005, p. 158)

In the next phase, the predominantly generic STI policy approach was replaced by a more thematic and sector-oriented one without reverting to out-dated and compromised approaches and top-down modes of governance.

Moving towards a new thematically oriented approach[3]

In 2003 the Advisory Council for Science and Technology Policy (AWT) published an influential paper, *Backing Winners* (AWT, 2003). After an extended period of predominantly generic STI policy, emphasis shifted to achieving "excellence" and creating "focus and mass" in selected "key areas and key technologies" (Wintjes, 2007).[4] To foster the creation of "critical mass", the government, together with industry and research institutions, would facilitate the development of joint agendas. "Focus and mass" in (research) capacity provided a rationale for a strategy to strengthen the thematic and sectoral orientation of STI policy (de Heide et al., 2013). An important component of this strategy was the "key areas approach", based on a proposal by the first Innovation Platform (see Annex 5.A1). It was argued that the creation of focus and mass in the research capacity of selected key areas was necessary to maintain a strong and internationally competitive position. The key areas selected were: flowers and food; high-tech systems and materials; water; chemistry; creative industry; and pensions and insurance. They were chosen for their perceived strategic importance (in terms of growth opportunities) or relevance to societal challenges.

As part of this approach, the Ministry of Economic Affairs introduced innovation programmes to support the relevant industrial sectors, under the so-called programmatic approach (den Hertog et al., 2012a). Its objective and scope were defined as follows:

> "Objective is top-performance on innovation themes. EZ develops therefore, in collaboration with the actors from the whole innovation chain, Innovation programmes targeted towards areas where the Netherlands could excel. Innovation programmes offer an integrated approach, addressing all relevant problems in a specific Key Area. For example by investing in R&D, exploiting knowledge, and increasing participation by SMEs. But also by stimulating export and investing in human capital. For a strong and coherent / consistent approach, EZ aims for co-ordination between Innovation programmes and existing initiatives from for example NWO and TNO. Innovation programmes will link as much as possible to international programmes such as the EU Framework Programme and EUREKA."[5]

There were ten innovation programmes. Many of the sectors covered were essentially those later covered by the top sectors (see section 5.3 below). Over 2006-10, the programme received more than EUR 1 billion in public funds, much of it through the Interdepartmental Funds for Economic Structuring (FES), also known as the gas funds. By far the largest share, EUR 924 million, was used for R&D grants. Matching R&D funds amounted to EUR 1 445 million, of which EUR 1 066 million from companies (den Hertog et al., 2012a). The innovation programmes also paid attention to other policy areas, such as human capital and internationalisation, but they were far less prominent than in the later top sectors approach. An evaluation by Dialogic (den Hertog et al., 2012a) was critical of the lack of alignment with international (EU) programmes. The innovation programmes predominantly funded R&D programmes and did not seem to have been very successful in achieving a lasting dialogue between the main actors in the sectors covered. Over 6 100 companies participated in some way (70% were small and medium-sized enterprises – SMEs), and 1 775 companies participated in the innovation projects with their own resources. The Dialogic evaluation found that many of the programmes lacked good problem analysis and had fuzzy goals. Moreover, the contributions of the innovation programmes to the achievement of the goals were not always clear.

Measures other than the key areas approach (primarily under the Ministry of Economic Affairs) were also taken to create focus and mass. They included the establishment of new technological top institutes (TTIs) and of co-ordination structures with additional funds for specific sectors (so-called *regie-organen*). The Ministry of Education, Culture and Science (OCW) identified specific strategic research areas – ICT, genomics and nano sciences – that were addressed by existing instruments and institutes. Part of the revenues from the extraction of natural resources in the Netherlands was allocated, via the FES (gas funds), to specific projects in order to foster focus and mass in certain parts of the knowledge infrastructure.[6]

Summary of major trends

- *R&D and innovation have moved up the policy agenda* as their importance has increasingly been recognised as a driver of economic growth (see Annex).
- *Policy shifted from an old-style industrial and sector-oriented policy* to a generic and technology-push approach, followed by a "new" sectoral approach. This approach, inspired by AWT's *Backing Winners*, relied on "focus and mass" and "key areas". It is the predecessor of the current "top sectors" approach, a major focus of this review (see section 5.3 below). One of the major differences between the key areas/innovation programmes and the current top sectors is the lack of the additional FES funds. In the top sectors, the players have to pool their existing funds.

The move towards a more thematic and sector-oriented approach was not the only important recent change in Dutch innovation policy. Other developments are:

- *A drive to increase the efficiency of public support by a combination of "streamlining" the set of instruments and increasing the share of fiscal suppor*t (delivered largely through generic tools) relative to direct support in providing public financial support for business-sector R&D. This led to a profound shift in the "policy mix".[7]
- *A shift in the financing of R&D in higher education institutions (HEIs) and public research institutes (PRIs) from flow 1 (block grant) to flow 2 (project-based) funding*. More emphasis was placed on the valorisation of knowledge from HEIs and PRIs, especially by SMEs, which have engaged more in collaborative R&D programmes.
- *Increased stakeholder involvement* in the process of policy formulation (stakeholder consultation in defining thematic policy as in the key areas approach) and in policy delivery and implementation (top teams, top consortia for knowledge and innovation –TKIs) and evaluation (top sectors); stronger emphasis on the so-called "triple helix" (de Heide et al., 2013).

Summarising policy developments over the longer term, Velzing (2013) makes the following observations: i) that much of the recent history of Dutch innovation policy has focused on stimulating technologically oriented R&D; ii) that there has been a recurrent debate on the balance between generic and specific policies; iii) that there has been an increasing emphasis on co-operation with a view to stimulating companies to invest more in R&D, improving the market-oriented focus of knowledge institutes (HEIs and PRIs), increasing shared knowledge between companies and knowledge institutes, and creating stronger networks and clusters; iv) that there has been a growing separation between making and executing policy; and v) that attempts have been made to make innovation policy more transparent, e.g. through simplifying procedures (especially for SMEs), using more external advisory committees, and making greater use of programme evaluation.

5.2. Main policy actors

Like many other advanced OECD economies, the Netherlands has witnessed a steady expansion in the number and range of actors with an innovation policy stake. More ministries and agencies play a role in supporting innovation. The private sector's role in formulating and implementing policy, for example through public-private partnerships (PPPs), has increased. The research-performing landscape is increasingly fragmented, as more public research centres and more firms conduct R&D. The growing role of regions and the European Union in innovation policy adds an additional dimension to governance.

Government ministries

The main actors in the design and definition of Dutch innovation policies are the Ministry of Economic Affairs (EZ) and the Ministry of Education, Culture and Science (OCW). Other ministries also sponsor innovation programmes based on their portfolios of activities.

The Ministry of Economic Affairs is responsible for promoting competitiveness, entrepreneurship and innovation. It also facilitates and strengthens links between research institutes and the business sector and works to create good framework conditions for business and economic development. Programmes and policies under its control primarily focus on business R&D and innovation. Policy schemes funded by the ministry are primarily implemented by the Netherlands Enterprise Agency (see below), the Dutch governmental organisation responsible for implementing sustainability, innovation and international business programmes. The Ministry of Economic Affairs also contributes to the funding of the Netherlands Organisation for Scientific Research (NWO) and the Technology Foundation STW (see below), the TO2 (from the Dutch *Toegepast Onderzoek Organisaties*, i.e. organisations dedicated to applied research) applied research institutes, and the European Space Agency (ESA). In the areas of agriculture, ecology and the environment, the Ministry of Economic Affairs funds research programmes at the Wageningen University and Research Centre (WUR) (see Chapter 4).

The Ministry of Education, Culture and Science is responsible for defining strategies and policies for public-sector education and research. Most of its budget covers institutional block funding for HEIs. The Ministry of Education, Culture and Science, together with Ministry of Economic Affairs, co-ordinate the science policy agenda of the national government and contribute to the definition of international science policy at the EU level and beyond. It largely leaves the choice of research priorities to research entities and individuals. However, it provides additional funding for some research areas of social or economic importance, such as genomics, ICT and nanotechnology. Ministry of Education, Culture and Science is a major funder of NWO and the Royal Academy of Arts and Sciences (KNAW) (see below). It also provides funding to major international science organisations such as CERN, ESA and EMBL.

As in many countries, other government ministries also develop sectoral research and innovation programmes or establish research institutes (Table 5.1 provides information on the R&D expenditures of different ministries):

- The Ministry of Defence funds the defence-related research programmes of TNO (the Netherlands Organisation for Applied Scientific Research), NLR (the National Aerospace Laboratory) and MARIN (the Maritime Research Institute Netherlands). It also has a central R&D budget to develop defence-specific technology.

- The Ministry of Health, Welfare and Sport (VWS) is responsible for the National Institute of Public Health and the Environment and the Netherlands Institute of Social Research, both of which have an important research role. VWS also provides research funding for the Netherlands Cancer Institute and the Netherlands Institute for Social Research. Some of the health-related research programmes are managed by the Netherlands Organisation for Health Research and Development (ZONMW).
- The Ministry of Infrastructure and the Environment (I&M) has developed a knowledge and innovation strategy that is implemented by a Knowledge, Innovation and Strategy Directorate inside the ministry. It is also responsible for the Netherlands Environmental Assessment Agency (PBL) (see below); the Royal Netherlands Meteorological Institute (KNMI), a national institute that studies the weather, climate and seismology; four Rijkswaterstaat centres of excellence (water; transport and infrastructure; construction; ICT and data management); and the Netherlands Institute for Transport Policy Analysis (KiM). I&M also funds TNO and the major technological institutes (TTIs) and provides research universities and other research organisations with contract funding, in some cases through research funding agencies such as NWO, the Netherlands Enterprise Agency (RVO) and the National Institute for Public Health and the Environment.
- The Ministry of Foreign Affairs devotes a portion of its budget to fund research at the Netherlands Institute of International Relations Clingendae, the African Studies Centre and the Royal Tropical Institute.

Table 5.1. Budgeted R&D expenditure (GBAORD), by ministry, 2011-17

EUR millions

	2011	2012	2013	2014	2015	2016	2017
General affairs	0.587	0.814	0.574	0.574	0.574	0.574	0.574
Foreign affairs	80.941	71.429	73.075	68.902	65.528	65.528	65.528
Security and justice	24.943	26.159	24.810	25.520	25.373	25.453	25.425
Interior and Kingdom relations	16.830	19.535	14.425	12.600	12.600	12.600	12.600
Education, culture and science	3357.358	3373.701	3318.612	3342.890	3288.890	3305.304	3324.304
Defence	70.223	70.623	63.076	63.901	60.970	58.775	58.774
Infrastructure and the environment	116.735	99.670	93.123	71.380	55.919	53.943	53.099
Economic affairs, agriculture and innovation	1081.261	1051.270	999.803	900.402	755.348	638.459	608.528
Social affairs and employment	0.720	1.385	1.620	1.520	1.300	1.360	1.360
Health, welfare and sport	225.461	176.938	160.918	145.111	138.110	136.542	136.542
Total	**4975.059**	**4891.524**	**4750.036**	**4632.800**	**4404.612**	**4298.538**	**4286.734**

Source: Rathenau Institute database, based on the ministries' 2013 budgets.

Research and advisory councils

The Netherlands has long established advisory councils to government and policy bodies in various areas, including science, technology and innovation (STI). Many were created several decades ago and undertake broad consultations before reaching a final decision. Councils and advisory bodies represent multiple actors of the innovation system, including, in some cases, the business sector. This section describes the main advisory councils with at least a partial focus on STI policy.

The Advisory Council for Science and Technology Policy (AWT), created in 1990, is an independent strategic advisory body. It advises the government and parliament on STI policy. It has a maximum of 12 members from research institutes and business-sector organisations who participate as individuals rather than as representatives of their organisation of affiliation. AWT has 11 administrative and secretariat staff who help prepare meetings and draft reports and background studies. In most cases AWT provides advice on knowledge and innovation policy at the request of the Ministry of Education, Culture and Science or the Ministry of Economic Affairs. Occasionally, other government departments or parliament request advice and opinions on specific policy issues. AWT is also free to make judgements and statements to highlight concerns about specific policy developments. AWT defines a multi-annual work programme in consultation with OCW and EZ. The 2014-17 programme focuses on: the meaning of a changing world; ambitious policy in time of austerity; and balanced growth in the knowledge economy. AWT disseminates its findings through reports, advisory letters and background papers. It also publishes annual reports and is evaluated every four years by an external independent commission, according to the guidelines of the *Advisory Bodies Framework Act*.

The Royal Academy of Arts and Sciences (KNAW) was founded in 1808 as an advisory council to the Dutch government on matters related to science, arts and research, as stated in the *Higher Education and Research Act*. It has approximately 500 members who are active in the full spectrum of scientific and academic research. They are selected on the basis of academic excellence and are appointed for life. Most are either outstanding Dutch scientists or scholars active in the Netherlands or abroad. Some are not Dutch nationals. The Academy is also responsible for a number of national research institutes (see Chapter 4). It delivers reports, memoranda or foresight studies on science and research matters, prepared by KNAW members and experts selected on the basis of their qualifications and the absence of conflicts of interest. In order to preserve their independence, authors of reports or studies receive no compensation for their work. Five advisory councils assist KNAW in the preparation of reports and analysis: the Council for Earth and Life Sciences; the Council for the Humanities; the Council for Medical Sciences; the Council for Technical Sciences, Mathematical Sciences and Informatics, Physics and Astronomy, and Chemistry; the Social Sciences Council. The KNAW Executive Board has also established a number of committees on topics such as education, scientific ethics and integrity. The members of KNAW's councils or committees may or may not be KNAW members; they represent universities, research institutes, civil organisations and the business community.

The Netherlands Scientific Council for Government Policy (WRR) is an independent advisory council to the Dutch government. It was created in 1972 as a temporary advisory council but its existence was formalised in 1976 by the *Act Establishing a Scientific Council on Government Policy*. It is responsible for advising the government on broad issues of importance for Dutch society. Unlike other councils or advisory bodies, it is not restricted to one policy sector, but seeks to identify current and future trends that should be addressed in political debates. WRR has from 5 to 11 members who meet every two weeks and take an active part in the research and preparation of reports and analysis. They are appointed for a term of five years (renewable for a maximum of one term). WRR members are generally academics with experience in fields ranging from public governance, to socioeconomic sciences, to medical and natural sciences, to energy and engineering. In addition to its members, the Council has external advisory members who represent other government institutes, such as the Netherlands Environmental Assessment Agency, the Netherlands Institute for Social Research, the Netherlands Bureau of Economic Policy Analysis, and Statistics Netherlands. Each year, WRR defines a programme of work in consultation with the prime minister. Following its first external evaluation in 2001, WRR started to work more extensively with foreign experts and other stakeholders. WRR is a member of the international Network of Strategic Policy Agendas together with similar councils in Sweden, France and Ireland and the Bureau of European Policy Advisers, based in Brussels.

The Netherlands Bureau for Economic Policy Analysis (CPB) was established in 1945 as a government advisory body on socioeconomic issues. It conducts research independently and at the request of the government, parliament, individual members of parliament, trade unions or employers' organisations. Its analyses contribute to economic decision making. CPB delivers quarterly economic forecasts and conducts research on themes such as the economic impacts of ageing, globalisation, health care and education. Two of CPB's research areas are more directly related to STI policy: issues related to the education and scientific system and knowledge more generally; and issues related to the Internet economy, intellectual property and innovation policy more broadly. CPB is under the Ministry of Economic Affairs and its director is appointed by the minister in consultation with other government bodies.

The Social and Economic Council of the Netherlands (SER) is an advisory body established in 1950 by the *Industrial Organisation Act*. It advises the government and parliament on national and international social and economic policy. SER is fully independent of the government as it is financed by business organisations and trade unions. It provides advice on employment issues, social security, regulatory policy, environmental planning, etc. It occasionally publishes reports related to innovation and research policy, notably with a focus on education, skills and lifelong training. Its advisory reports are generally published and available to the public. It also delivers guidance and supervision on issues related to corporate governance, consumer policy and trade. SER is composed of three groups of 11 members for a total of 33. The three groups represent employers (including associations of SMEs), unions and "Crown" members appointed by the government. Crown members are independent experts, often university professors with a chair in economics, finance, law or sociology. The president of the Dutch Central Bank and the director of CPB are Crown members. The president of SER is appointed by the government.

The Netherlands Environmental Assessment Agency (PBL) is the national institute for strategic policy analysis on the environment and spatial planning. It results from the merger of two agencies for spatial planning and the environment. It conducts research, analysis and evaluations to contribute to policy debate and to provide advice to the government, parliament and other policy actors. PBL research focuses on energy and climate change, water, agriculture, food, urban and rural development and spatial planning. It has recently developed studies on clusters and agglomeration economies in relation to the top sectors approach. The PBL research budget is EUR 30-40 million a year.

Major research and innovation funding agencies

The main funding organisations for R&D and innovation in the Netherlands are the Netherlands Organisation for Scientific Research (NWO), the Royal Academy of Arts and Sciences (KNAW) and the Netherlands Enterprise Agency (RVO) (Table 5.2).

Table 5.2. Budget overview of major funding agencies, latest available year

EUR millions

Public R&D and valorisation	Business R&D and innovation
NWO: EUR 623 million	
STW: EUR 84 million (of which EUR 44 million from NWO)	**RVO**: EUR 668 million*
KNAW: EUR 142 million	

* This figure does not include support to business innovation through the WBSO and RDA tax measures, which amounted to EUR 1 118 million in 2013.

Source: Rathenau Institute, www.nwo.nl, www.stw.nl.

NWO is a research-funding agency under the responsibility of the Ministry of Education, Culture and Science. It is responsible for allocating research funding, raising the quality of scientific research, and facilitating knowledge transfer. It primarily focuses on academic research and receives most of its budget from the Ministry of Education, Culture and Science (usually approximately 80%) and some from other ministries. It has eight divisions (one of which is STW, see below), three foundations (the National Computer Facilities, FOM Foundation for Fundamental Research on Matter and the WOTRO Science for Global Development) and nine research institutes active in different disciplines (see Chapter 4). NWO also has temporary task forces responsible for guiding and funding research in areas prioritised by the government. It allocates funds on a competitive basis to academics and research teams. Independent experts select the research proposals that are cleared for funding.

The Technology Foundation STW was created in the late 1970s and funds research programmes in the technical sciences, with a focus on knowledge transfer from researchers to users (generally business organisations). It is an independent organisation affiliated with NWO. STW's budget is largely derived from NWO (EUR 44 million) and the Ministry of Economic Affairs (EUR 22 million). Co-funding partners in each project provide an additional EUR 8 million. Other partner organisations provide in-kind contributions representing approximately EUR 10 million.

In addition to NWO and its related organisations, KNAW funds basic research programmes, scholarships, mobility schemes and KNAW research institutes. KNAW's total budget in 2012 was EUR 152 million of which EUR 142 million financed research programmes and KNAW's institutes (the latter received 88% of this budget in 2012 – see Chapter 4). KNAW's budget primarily comes from the Ministry of Education, Culture and Science.

RVO promotes business development with a focus on sustainability, agriculture, innovation and internationalisation. It is part of the Ministry of Economic Affairs and was created in 2014 as a merger of NL Agency and Dienst Regelingen (which implemented and funded programmes on behalf of the Ministry of Economic Affairs and the former Ministry of Agriculture, Nature and Food Quality). RVO provides information and advice on international business, intellectual property, implementation of environmental policy, and EU framework programme regulations. It also promotes the internationalisation of Dutch companies and attraction of foreign direct investment (FDI). It is responsible for funding R&D and innovation through different programmes for different ministries. However, its main role with respect to policy implementation is related to the delivery of fiscal measures and direct financial support. The main R&D fiscal measures implemented by RVO are the tax credit for R&D (WBSO) and the Research and Development Allowance (RDA)[8]. The main direct measures implemented or managed by the agency are the SME+Innovation Fund as well as the TKI allowance and MIT (see Section 5.4).

5.3. Governance: Agenda setting, co-ordination, evaluation and the top sectors

Agenda-setting and co-ordination

The preceding description of major STI policy actors shows the strong presence of councils and advisory bodies with an active role in Dutch policy making. Councils and advisory institutions cover the range of policy making, including science, technology, innovation and economic development more broadly, and they issue policy documents and statements that actively shape the political agenda. In addition, they act as co-ordinators not only across government ministries and parliament, but also of stakeholders in the innovation (and more broadly socioeconomic) system that are represented in many of these bodies. For example, business organisations are represented in AWT and the committees of KNAW. CPB and SER work with trade unions and employers' associations.

Most of these advisory organisations have existed for decades and have operated in accordance with the Dutch tradition of consensus-oriented policy making. Consultations among academics, business-sector representatives, trade unions and policy actors have provided space for consensus to emerge in a more "bottom-up" manner (in various expressions of the so-called Dutch '*polder model*'[9]) than is typical of many OECD countries. The process tends to work against attempts at "top-down" steering and instead provides for "negotiated change" in innovation policy and its governance. At the same time though, consensus-oriented decision making means that it can be difficult and can take long to decide on changes, however necessary.

Between 2004 and 2010 agenda setting was the role of the Innovation Platform, which had high-level representation from government (the prime minister and ministers of Economic Affairs and of Education and Science), business, knowledge institutes and independent experts (Boekholt and den Hertog, 2005). At present, a considerable amount of research system co-ordination takes place in the context of the top sectors (discussed below), which rely on co-ordination of the different communities (notably academia, business organisations and government, represented in the top teams) and share some of the features of the consensual "polder" model. Agenda setting in the top sectors concerns only part of the system and takes place on a biannual basis, i.e. less than the typical duration of a full policy cycle. Following the demise of the Innovation Platform there do not appear to be any formal mechanisms for agenda setting outside of the top-sector disciplines, technology areas and economic activities or for longer-term orientation and system-level priority setting.

The Dutch Parliament's House of Representatives and Senate have both created education, culture and science committees and economic committees as a basis for consultation between parliament and the government. Other co-ordination bodies are the government-level Economic Affairs, Infrastructure and Environment Subcommittee

(REZIM), which consists of the ministers most closely involved in these matters, and its counterpart at the ministry level, the Economic Affairs, Infrastructure and Environment Committee (CEZIM). Both deal with issues related to the economy, science and research policy, higher education and innovation. Issues related to science and research policy are generally discussed at REZIM meetings and subsequently discussed by the government (ministers and state secretaries) for decision making. CEZIM conducts the preparatory work for decision making, following discussions at REZIM.

Evaluation

The Netherlands has a long history of evaluating public research and was among the pioneers in introducing formal evaluation mechanisms, some of which date back more than two decades. Evaluation enjoys broad acceptance among stakeholders. It is seen as a constructive management tool that helps organisations improve their performance. Practice in the Netherlands is distinguished from international trends in that evaluation has no direct consequences, no central co-ordinating organisation[10] and no link to national goals (van Drooge et al., 2013). The organisations to be evaluated have a considerable say in the terms and scope of evaluations. This has contributed to the development of a diversity of approaches (e.g. evaluations at the level of research groups or research centres, disciplines at the national level, sometimes with exceptions for one organisation). This diversity complicates an assessment of the effectiveness of the evaluation mechanisms. Nevertheless, scores for all criteria – academic quality and productivity, relevance and feasibility – have risen over time and today almost all research qualifies as internationally competitive (van Drooge et al., 2013).

Moreover, with a tradition of sophisticated evaluation of policy instruments, the Netherlands is among the world leaders in the use of novel evaluation methodologies (Hassink et al., 2013). Evaluations of government instruments that support business innovation are conducted regularly and generate considerable policy interest and attention. Another implication of the Dutch evaluation culture is that policy is generally responsive to the findings of evaluations and that policy formulation strives to be evidence-based. Many evaluations have served to improve the efficiency and effectiveness of instrument implementation, such as the successive evaluations of the tax credit and the innovation voucher schemes. So far however, policy evaluation has emphasised the instrument level. Looking to the future it would be profitable to develop an analogous level of experience in system-level evaluations and social cost-benefit analyses.

The top sectors approach

Rationale and key features

A large part of innovation policy co-ordination currently takes places under the top sectors approach, an industrial or "enterprise" policy formally introduced in February 2011 (Ministry of Economic Affairs, 2011), although it was anticipated by similar policy initiatives over the preceding decade.

The decision was motivated by concerns over the Netherlands' international competitiveness and particularly by the difficulties faced by Dutch exporters for expanding into the emerging markets of the BRICs (Brazil, Russian Federation, India, People's Republic of China). The rationale for the top sectors approach underlines the link between innovation and export performance and foresees a central role for innovation policy and its instruments.

Leveraging business-sector R&D is one of the objectives of the top sectors approach. It follows from a long-standing concern in the Netherlands that the considerable public resources devoted to R&D and innovation do not appear to induce concomitant investments from business. As Chapter 3 showed, while government budget appropriations or outlays for research and development (GBAORD) as a share of GDP are on par with other advanced systems, business expenditure on R&D as a share of GDP is close to the EU27 average. To raise business R&D and innovation performance, the approach enlists the strong capabilities of public research performers. It argues for an increase in the applicability of public research, placing it, to a greater extent than previously, at the service of Dutch industry, especially of SMEs.

Another key objective is greater coherence in government policy in support of business by simplifying the range of interventions and organising them along lines suited to the specific opportunities and constraints of vital economic sectors. A sectoral approach to government policy, it has been argued, would overcome traditional barriers to co-ordination across government ministries and departments. To this end it incorporates, besides interventions focused on R&D and innovation, co-ordination of interventions in policy areas such as skills and foreign policy. A sectoral rather than a thematic focus on social challenges was chosen because it is more readily recognised by the business sector. To achieve the above objectives the top sectors approach envisages: (i) the focusing of policy attention and interventions – in particular the alignment of public R&D and innovation resources – on a few sectors in order to maximise economic impact; (ii) much closer co-ordination of businesses, government and knowledge institutes with a view to creating "a totally new form of public-private co-operation" (Ministry of Economic Affairs, 2011).

Nine sectors (not directly corresponding to international classifications) were singled out: agri-food; horticulture and propagation materials; high-tech systems and materials (HTSM); energy; logistics; creative industry; life sciences; chemicals; and water. These are largely clusters of economic activities that correspond to Dutch industrial strengths. In 2011 the nine sectors accounted for over 80% of business R&D (96% in 2010) and 55% of exports but under 30% of value added and employment (Box 5.1)[11].

While in principle the approach foresees concentrating government attention and resources on a few sectors, in practice the choice of nine broad sectors and the modest resources mobilised (largely diverted from existing funding) mean that the emphasis is more on joint programming and co-ordination than on targeting.

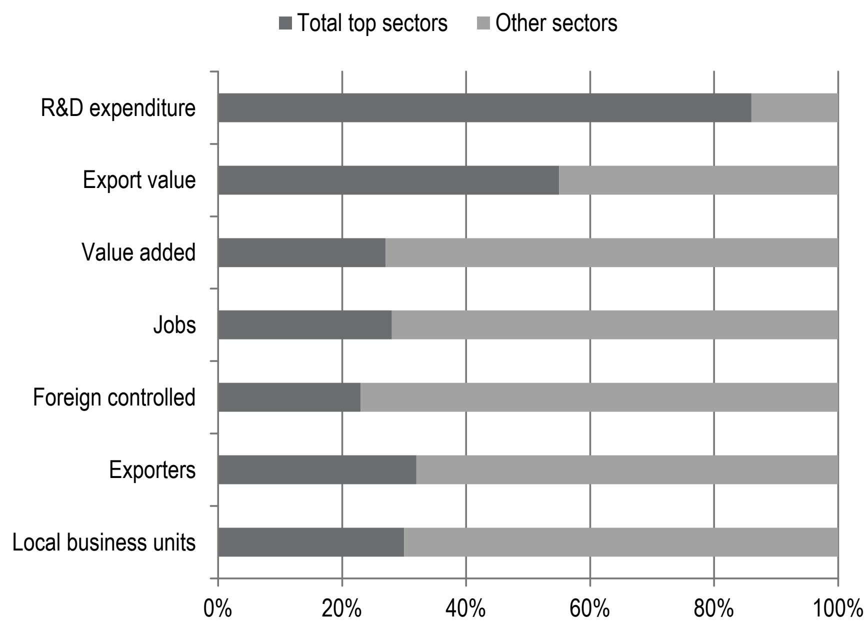
The top sectors approach was inspired in part by the agriculture sector's so-called "golden triangle" of enterprises, knowledge institutes and government. Their collaboration is seen as having been critical for the success of this important sector (the Netherlands is the world's second largest exporter of agricultural products). It involved the development of a common vision and multi-year agreements, the financial commitment of all parties, the linkage of education with private-sector needs and the development of close links between entrepreneurs and research.[12]

Top-sector programming is similar. It involves the joint drafting of thematic policy agendas by teams of representatives from the various stakeholders. The research and innovation agenda is by far the most prominent to date and the largest in terms of spending. The human capital agenda strives for better alignment of education with the needs of the top sectors. Other areas of joint programming include the reduction of administrative burden and foreign policy, such as economic diplomacy with "Holland branding" (Ministry of Economic Affairs, 2011).

Box 5.1. Composition of the top sectors

The top sectors encompass more than 290 000 local business units, i.e. 30% of all local business units in the Netherlands. Together, they account for a quarter of total value added and 1.4 million jobs, or 28% of employment. A key feature of the top sectors is their export orientation. At EUR 175 billion, the top sectors generate 55% of the Netherlands' total export value of goods. Foreign-controlled top sector local units generate almost half of total exports. In 2011 the nine top sectors accounted for more than 80% of total business R&D expenditures (96% in 2010, before the changes in business R&D measurement). The high-technology systems and materials sector generates almost half of total R&D expenditures.

Figure 5.1. Share of top sectors by various characteristics, 2011



Source: Statistics Netherlands (2013).

In many ways, the top sectors approach is the latest in a long line of policy initiatives aimed at research co-ordination through PPPs (Table 5.3). According to Hessels and Deuten (2013), the Dutch government has supported research PPPs of various forms since the 1980s, including "innovation-oriented research programmes", the leading technological institutes (TTIs) and interdisciplinary multi-actor programmes financed from national gas revenues [the so-called investment grants for knowledge infrastructure (BSIK) and the economic structure enhancement fund (FES)]. These temporary arrangements sometimes took the form of virtual research institutes (Hessels and Deuten, 2013). In the past decade in particular, national initiatives with a regional ("peaks in the delta") and sectoral dimension (key areas, innovation programmes) emerged (de Heide et al, 2013). Indeed continuity is most evident in terms of the *choice* of sectors. It was during this time that co-ordination in most of the sectors now covered by the top sectors approach began.

Table 5.3. Overview of the most important Dutch policy initiatives for research co-ordination

	←	1985	1990	1995	2000	2005	2010	2015
Innovation-oriented research programmes								
Graduate schools								
ICES/KIS, BSIK, FES								
Leading technological institutes (TTIs)								
Key areas/TTIs								
Top sectors and TKIs								

Source: Adapted from Hessels, L. and J. Deuten (2013), "Coordination of research in public-private partnerships: lessons from the Netherlands", *Rathenau Institute Working Paper* 1302.

Among the novel elements of the top sectors approach is the emphasis placed on alignment, which concerns a much greater share of public R&D budgets (Velzing, 2013). While it initially emphasised the sectoral dimension, it has sought, particularly over the past year, to reflect emerging social challenges and to develop a regional planning dimension.

Governance mechanisms and their implications

The approach introduces new forms of governance. Whereas traditional approaches to industrial policy are often government-centred, industry representatives are at the centre of the co-ordination process in the top sectors. So-called "top teams", composed of high-level representatives from industry, public research and government, draft knowledge and innovation agendas which they submit to the government for consideration. The government evaluates each top team's proposed agenda, which includes a strategic plan and relevant instruments. The government's evaluation takes into account the level of ambition, the level of stakeholders' commitment, the degree of openness, the balance between the social and economic agendas, and the extent to which the objectives can be monitored and evaluated. The relationships and sectoral plans are then formalised in bi-annually updated innovation contracts. For its part, the government undertakes to develop sector-specific policies across ministerial portfolios, including education, innovation, and foreign policy, and to reduce the regulatory burden.[13]

Implementation of the innovation contracts is mainly undertaken by the top consortia for knowledge and innovation (TKIs). Some top sectors have more than one. Each receives a TKI allowance from the government, which is intended to reward business funding allocated to the agendas (Ministry of Economic Affairs and Ministry of Education, Culture and Science 2013) (discussed in section 5.4). A total TKI allowance of EUR 83 million was allocated in 2013 and was distributed across the various TKIs in line with the private contributions (Table 5.4).

Table 5.4. TKI allowance allocations for 2013

Top sector	TKI	TKI allowance (EUR millions)	Parties
Agri&food	Agri&food	8.60	222
Chemicals	Bio-based economy	2.53	50
	ISPT	4.21	67
	Smart polymeric materials	2.00	86
	Nieuwe Chemische Innovaties	2.99	119
Creative industry	CLICKNL	0.06	17
Energy	EnerGO	0.34	57
	SWITCH2SmartGrids	0.13	55
	Solar energy	2.59	52
	Gas	3.60	113
	Wind op Zee	1.52	17
High-tech systems and materials	HTSM	28.14	201
Life sciences	Life sciences health	8.10	113
Logistics	Logistiek	1.68	289
Horticulture and propagation materials	Uitgangsmaterialen	1.29	33
	Tuinbouw	3.82	55
Water	Maritiem	7.19	214
	Deltatechnologie	0.62	74
	Water technology	3.88	145
Total		83.29	

Source: Ministry of Economic Affairs (2013c), Table 2.7.

The current innovation contract was signed in October 2013, and foresees an annual research investment of almost EUR 2 billion, of which EUR 970 million contributed by companies in the top sectors. The latest contracts specify the relation of each research agenda to the EU's Horizon2020 in an on-going effort to align the top sectors better with social challenges. Accordingly, a budget of EUR 36 million has been set aside to co-fund Dutch public participation in Horizon2020 on areas related to social challenges over 2014-17[14]. Moreover, special efforts are made to encourage participation by SMEs. For instance, from 2014 onwards, SMEs can contribute the first EUR 20 000 of their TKI participation in kind rather than in cash .In addition, each TKI has a contact point for SMEs to help them identify appropriate innovation programmes and activities.

Hessels and Deuten (2013) examine top-sector co-ordination issues. Drawing on the Netherlands' rich historical experience with research PPPs, they find that each sector faces its specific coordination problems (Table 5.5). For instance, whereas lack of a coherent research agenda may be a problem for public research performers, the problem for firms may be a lack of trust or of organisational capacity. Co-ordination across the public-private research boundary also implies interaction between fundamental and applied research. In addition, co-ordination problems change over time in response not only to shifts in the composition of participants but also to external developments driven by both market and knowledge dynamics.

Hessels and Deuten (2013) observe that most of the top-sector co-ordination problems are not new but were already apparent in previous attempts to promote research PPPs. They observe that the current situation largely reflects contingent circumstances, such as the composition of the initial consortium and the personal leadership style of the director. It would be important for policy design to aim to systematise learning from past experiences and to tailor governance arrangements to the specific co-ordination problems of each sector.

Table 5.5. Co-ordination problems per top sector

	Co-ordination problems among firms	**Co-ordination problems between firms and knowledge institutions**		**Co-ordination problems among knowledge institutions**
	Organisational capacity in the industrial sector	*Share of large firms*	*Experience with PPPs*	*Organisational capacity in the scientific field*
Chemistry	Large	Large	Large	Large
High-tech systems and materials	Large	Large	Large	Average
Agri&food	Average	Large	Large	Large
Horticulture and propagation materials	Average	Average	Average	Large
Life sciences and health	Small	Average	Large	Large
Water	Large	Average	Small	Average
Energy	Small	Large	Average	Average
Logistics	Average	Small	Average	Small
Creative industry	Small	Small	Small	Small

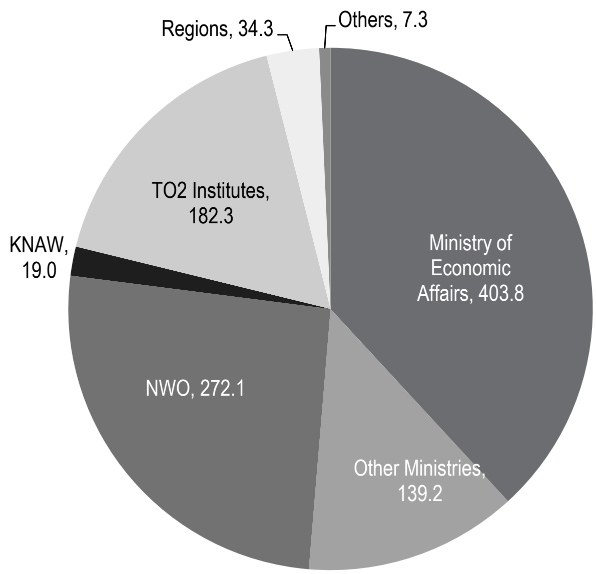
Source: Hessels, L and J Deuten (2013), "Coordination of research in public-private partnerships: lessons from the Netherlands", *Rathenau Institute Working Paper* 1302.

Top Sectors funding

The public budget allocated to the top sectors is difficult to calculate accurately because it is mostly diverted funds that are subject to co-funding from industry or the EU. It also incorporates R&D funding from ministries (e.g. Health Welfare and Sport, Infrastructure and the Environment, Defence) and sub-national authorities. The Dutch government estimates that, excluding regional and EU funding, between EUR 1 billion and EUR 1.1 billion will be made available to the top sectors every year for 2013-16 (see Figure 5.2 and Table 5.6 for a 2014 breakdown by funding sources). Of this only the TKI funding allowance (between EUR 50 million and EUR 130 million a year) can be clearly identified as additional funding. Between EUR 50 million and EUR 30 million a year are foreseen for specific education and labour market interventions, whereas EUR 700-900 million a year are foreseen for research and innovation.

Figure 5.2. Expected public sources of financing for the top sectors, 2014

EUR millions



Source: Nederlands Kennis- en Innovatiecontract 2014-2015, Annex to Monitor Bedrijvenbeleid: Bedrijvenbeleid in Beeld 2013, Ministry of Economic Affairs.

Table 5.6. Government ministry contributions to the top sectors, 2014-15

EUR millions

	2014	2015
Ministry of Economic Affairs	403.8	394.2
Ministry of Health, Welfare and Sport	71.6	59.1
Ministry of Education, Culture and Science	44.0	44.0
Ministry of Infrastructure and the Environment	11.3	36.9
Ministry of Defence	11.0	11.0
Ministry of Foreign Affairs	1.4	1.4

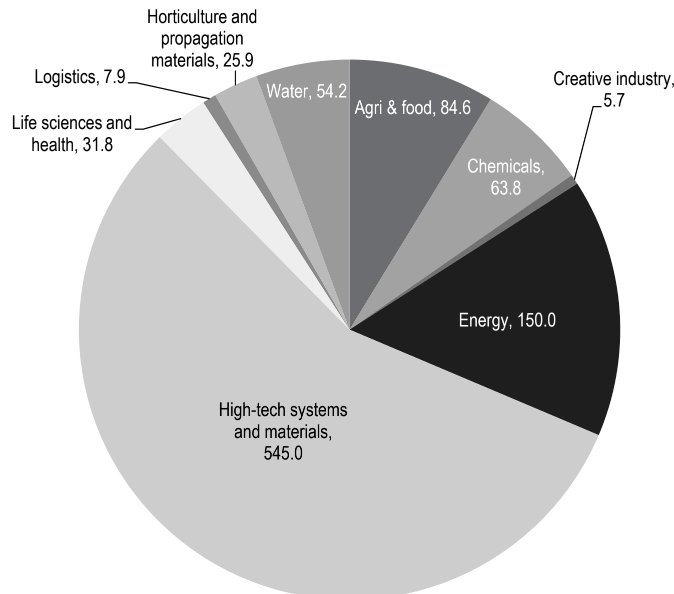
Note: Ministry of Education, Culture and Science contributions do not include funding aligned via the NWO.

Source: Nederlands Kennis- en Innovatiecontract 2014-2015, Annex to Monitor Bedrijvenbeleid: Bedrijvenbeleid in Beeld 2013, Ministry of Economic Affairs.

The business sector is expected to match this public funding with substantial investments of its own, which are expected to be close to EUR 1 billion a year in 2014-15 distributed across all top sectors. By far the biggest contribution (over 50%) is expected in high-tech systems and materials, followed by energy and agri&food (Figure 5.3).

Figure 5.3. Expected private-sector investments in the top sectors, 2014

EUR millions



Source: *Nederlands Kennis- en Innovatiecontract 2014-2015*, annex to *Monitor Bedrijvenbeleid: Bedrijvenbeleid in Beeld* 2013, Ministry of Economic Affairs.

Opportunities, trade-offs and risks

The top sectors approach has many of the characteristics of modern approaches to industrial policy, especially in terms of the emphasis on co-ordination and alignment, the important role of stakeholder demand, and the commitment to monitoring and evaluation. At the same time, it differs from other modern approaches in important respects. The emphasis on clusters of economic sectors, as opposed to tasks or activities (as in e.g. the EU's *smart specialisation* approach), is one of them. Notwithstanding the commitment to evaluation and continuing efforts to ensure openness in each of the top sectors, elements of the approach, such as the emphasis on sectors of strength (with implications for the representation of incumbents versus challengers) and the absence of a search for new niches, make it somewhat less dynamic than other forms of modern industrial policy.

As an approach to innovation policy, it reflects current thinking to a considerable extent. Its "all-of-government" approach and ability to integrate interventions across government departments into innovation policy is in line with calls for holistic approaches that recognise the systemic nature of innovation. Such an approach increases the likelihood that bottlenecks outside the traditionally narrow remit of innovation policy will be identified, and that sufficient attention and resources will be diverted to tackle them. It also introduces novel forms of governance, through the involvement of stakeholders not only in policy formulation but also in policy delivery and implementation, which will certainly be watched with interest by international policy peers.

Any approach that favours some parts of the system at the expense of others is likely to be debated and the top sectors approach has been no exception. Within the Netherlands there has been public discussion of its possible impacts on the innovation system (Box 5.2). An *OECD Economic Survey* (OECD, 2012) expressed concerns regarding its possible impacts on the wider business sector. Many of the concerns raised are familiar to almost any debate about selective industrial policy: the government has incomplete information to pick future winners, the process runs the risk of capture by well-organised interests, and co-ordination processes can be bureaucratic and inefficient. Other arguments take issue with specific aspects of the top sectors approach. Among them are claims that a sectoral approach does not take account of global value chains, that it risks diverting resources from horizontal policies related to education, fundamental research and the provision of public goods more generally, and that the gains from co-operation between business and government can be overrated.

Moreover, it has been argued that some aspects of the approach may undermine its own objectives. There are concerns with the selection of sectors, the alleged tendency to favour incumbents at the expense of challengers, the alleged lack of sufficient "critical mass", and the balance between small and large firms. A common objection to the current choice of sectors is that it is backward- rather than forward-looking, especially in terms of emerging social challenges. Another objection is that it is predominantly technology-oriented, with insufficient attention to non-technological innovation and the role of social sciences.

It would also be important to take account of other possible risks. A key issue is the complication of principal-agent dynamics when the government is part of the top teams and also has a mission to regulate markets. The design of an appropriate governance framework must be based on the understanding that the interests of government and business do not always overlap (even when the economy is concerned) and particularly if those involved are mostly large firms in certain sectors. The diversion of government policy attention and regulatory interventions in some sectors but not in others can compromise the coherence of the policy mix and of policy delivery. Of course there is always potential to improve co-ordination between government ministries and therefore lessen the regulatory burden faced by the sectors concerned. However, the Netherlands' good position in indicators of the business climate suggests that the magnitude of the likely improvements is small, and perhaps smaller than the risk of regulatory capture and of increased heterogeneity of regulation across sectors. Provided such pitfalls are avoided, sector-specific regulation can make sense in the interest of improving responsiveness to emerging technologies and to social challenges.

Vision projected by the top sectors

It would appear that at least part of the debate stems from issues relating to the vision projected for the future. The top sectors approach has been justified on grounds of the need to improve the Netherlands' international competitiveness in light of intensified global competition (particularly in emerging markets) and emerging social challenges. However, focusing on sectors of existing strength[15] is not always compatible with increasing overall competitiveness, and the motivating policy documents do not make the rationale for their selection sufficiently convincing. If the idea is to put limited public resources where they would have maximum economic impact, a clearer sketch of what would constitute desirable impact could be provided. Sectors of strength are unlikely to be sub-critical compared to other sectors nationally, so the argument appears to be that they need strengthening compared to the corresponding sectors of international competitors.

However, no references to supporting evidence have been provided in motivating policy documents. There are now plans to incorporate the needed international comparisons into current efforts to monitor progress and evaluate the top sectors.

A longer-term vision might say more about the type of economy that the Netherlands aspires to become and describe its qualities in terms that can be broadly recognised and accepted. In strengthening the legitimacy of the policy and ensuring its effective monitoring, it would be desirable to reinforce the rationale and inject further nuance and clarity, including in the specification of links between the overall vision and its intermediate objectives.

Progress in the top sectors and further development

The top sectors approach has existed for only two years so it is too early to assess its impact. An initial impression can be sketched on the basis of available but incomplete evidence on participation, instrument take-up and the governance of the top teams.

In spite of some criticism, the policy appears to enjoy broad acceptance, in part because of a general understanding of the need for long-term stability in the direction of innovation policy. The high levels of awareness, engagement and enthusiasm among businesses in top sectors such as high-tech systems and materials are encouraging. Progress has also been made in embedding the approach into policy making and research planning (Ministry of Economic Affairs (2013a; 2013b). Some of those involved in the drafting of the roadmaps report that the approach has created a new and positive dynamic in public-private co-operation. It may also have enhanced transparency, by bringing into the open bargaining activities by stakeholders that would likely take place anyway. In addition, it has a useful focus on deregulation to facilitate new firm creation and stream-line the business environment.

The co-ordination dimension of top sectors and the attention paid to it at the outset stand out as positive features of the approach. Initial indications are that this is already leading to some desired outcomes, in terms of aligning public research with industrial needs and encouraging the establishment of novel links between fundamental research performers and industry. Perhaps there is no better indicator of the approach's success in gaining recognition than the fact that it has been emulated by the construction sector, which has recently organised a partnership similar to a top sector but without government support.

At the same time, there are indications of variable awareness, development and commitment among the top sectors. The transaction costs entailed in participating in top sectors can be substantial for all parties concerned. It is likely that these will fall over time with learning and the formation of stable networks and routines. As the nature of co-ordination problems varies among the top sectors, it would be profitable to use evidence collected in the course of monitoring progress to facilitate learning and consolidate experiences into actionable lessons (Hessels and Deuten, 2013).

The participation of SMEs remains a challenge, especially, but not only, for SME-rich top sectors such as creative industries and logistics. Lack of resources for engagement is likely a limiting factor for smaller companies. The problem can be aggravated by the fact that larger companies are better organised and have more experience in dealing with government. The government recognises the problem and efforts are under way to encourage participation of SMEs through the MIT instrument (discussed below), the establishment of dedicated contact points for SMEs and the acceptance of in-kind contributions for small sums mentioned earlier. In addition, it would be important to ensure that their interests are taken into account in a manner that is sufficiently representative during the negotiation of the innovation contracts and the drafting of agendas. Merely hearing SME representatives' views in the top teams may not be sufficient, given the enormous diversity of this constituency; additional channels to solicit views and shape agendas (such as open consultations and surveys) may be required.

Box 5.2. Initial AWT observations on the top sectors, 2013

The *Adviesraad voor het Wetenschaps- en Technologiebeleid* (AWT) has been tasked to advise the Ministry of Economic Affairs on developments in the top sectors and is expected to publish a stocktaking report during 2014. In the meantime, as part of the 2013 Monitor of Enterprise Policy, the AWT was invited to submit first observations on the approach, focusing primarily on the main knowledge and innovation pillar. In the interests of policy continuity and stability, and reflecting on the strengthening of relations between industry, public research and government as a result of the top sectors, the AWT urged the government to continue with the approach. At the same time, it made several suggestions for improvement.

1. *Improve organisation/co-ordination*: the Ministry of Economic Affairs could be more proactive in guiding changes in the innovation system. AWT claims that the government should provide more (concrete) direction. Stakeholders now face uncertainty with respect to budgets, contact points, etc. Moreover, bureaucratic complexity may deter potential participants. Transparency in terms of the added value of the top sectors approach may increase commitment. The top sectors themselves are largely responsible for their organisation, but might benefit from professional support for communication and managing public-private partnerships. Another issue is the identified need for more clarity on how research agendas are constructed. Not all stakeholders understand or agree that "demand-driven research" basically means "industry-inspired research". There is a strong focus on fundamental research; crossing the "valley of death" by engaging in applied research is less prominent.

2. *Increase SMEs' involvement*: it appears that SMEs are not heavily involved in the top sectors. The AWT expresses a demand for more vision on the kind of SMEs that should be involved, pointing at the difference between a broad scope and a focus on the most innovative firms.

3. *Invest more in cross-sectoral (societal) challenges*: crossovers between the top sectors (and their TKIs) are believed to have huge innovation potential. So far, stakeholders in many top sectors have made few attempts join forces to address topics of strong economic and/or societal relevance. AWT suggests the need for more guidance on creating crossovers and points to Europe's Horizon2020, in which innovation is explicitly linked to broad societal challenges.

4. *Align national and regional policy*: regions appear increasingly concerned with innovation, making financing available and developing smart specialisation strategies. The AWT acknowledges the potential leverage regions can give the national top sectors approach, but warns of risks related to misalignment (duplications, omissions, inefficient variation in instruments, conflicting rules).

5. *Facilitate customisation of the top-sector instruments*: the top sectors approach builds on sector-specific measures as an addition to the Dutch generic innovation policy. However, stakeholders claim that the current top-sector instruments are insufficiently customised. Additionally, there is a demand for more support for services innovation, for instance through partnerships between manufacturing and service providers. A consideration might be to shift part of the budget for generic policy towards more specific policies.

Source: AWT (2013a), Advisory Letter: Initial Observation from the Top Sector Results.

The government appears to be aware of the limitations of the approach and is taking steps to adapt it. In response to the limitations of the sectoral focus, three crossover domains were introduced in ICT, bio-based economy and nanotechnology. Additional efforts have been made to identify cross-cutting projects, particularly in the high-tech systems and materials top sector. More active and more representative participation by SMEs, openness in the top sectors, and fuller representation of societal challenges all appear high on the agenda. A recently published progress report suggests that action is needed to improve alignment with societal challenges, provide more support for risky or innovative start-ups, and further simplify instruments on the basis of experience to date (Ministry of Economic Affairs, 2013a).[16]

Further efforts to strengthen the overall vision are needed. At the same time, it would be important to ensure sufficient support for PPP initiatives that fall outside the scope of the top sectors and to strengthen and rebalance the current landscape of generic instruments. Experience with co-ordination in the top sectors may be usefully applied in other parts of the economy. This is important for safeguarding the long-term dynamism of the Dutch economy and innovation system.

The risks and limitations outlined above, important as they are, relate in large part to aspects of the approach that, despite some assertions, do not appear to have materialised. In practice the approach has shown considerable flexibility. Flexibility is served by the numerous sectors chosen and the weak emphasis on concentration of resources, which is even weaker in areas with obvious trade-offs, such as funding for fundamental research (e.g. the requirement for industrial support in the NWO calls apply only to a minority of its competitive funding).

Though some in the Netherlands see the large number of sectors and the weak emphasis on concentration as failings of the approach, these seem to be sensible outcomes, in light of uncertainty over future sectors of high global demand, lack of evidence on the importance of unexploited scale economies for impact in these sectors and the uneven progress made in solving co-ordination problems. They can also be seen as a form of insurance against lock-in. Wide coverage and loose definition mean that individual companies can self-determine the sector(s) to which they belong, potentially allowing challengers and even companies operating in other sectors to participate in existing top sectors. However, despite efforts, and while there are no formal obstacles to the admission of new entrants into existing top sectors, in practice smaller and younger firms are not always adequately represented, especially in the top-sector leadership.

The question of sufficient scale or "critical mass" can be seen as the flip side of the issue of the variable ability to co-ordinate in different top sectors. Provided coordination works well, insofar as opportunities from unexploited scale economies exist, these will become apparent to participants, which should enable decisions to commit the requisite resources. From a policy perspective, therefore, the issue of sufficient scale is best considered as one related to co-ordination ability and its effects on eliciting quick responses to opportunities as they emerge rather than as an unqualified (and potentially wasteful) drive towards greater scale.

Looking to the future, it would be important to address shortcomings with respect to dynamism, for example, through formal mechanisms to introduce new top sectors, discontinue old ones and form dynamic demand-driven partnerships (e.g. through crossovers between the various top sectors) that coalesce into top sectors of their own. Formal arrangements that facilitate systematic learning, build trust and reduce transaction costs are likely to improve the impact of co-ordination in terms of pooling and aligning resources. The presence of such formal mechanisms would certainly facilitate transparency, strengthen legitimacy and therefore improve the approach's chances of long-term survival relative to the long line of its predecessors.

5.4. Supporting business R&D and innovation

Overview

The government plays an important role in shaping business innovation activities, and a key task is to provide suitable framework conditions. In the Netherlands, support to business innovation currently rests on two pillars: the top sectors approach, discussed above, and generic instruments and favourable framework conditions for all companies.

The government's efforts to provide favourable framework conditions focus on streamlining the regulatory framework for all businesses. Generic instruments predominantly take the form of tax incentives for investments in knowledge. Other generic instruments seek to improve the availability of finance (such as loans and credit guarantees), and smaller schemes address the demand side of innovation. In all, government support to business R&D was the equivalent of about 5% of business enterprise expenditure on R&D (BERD) (2009-11 average, the last three years of available data) (OECD, 2014a). The level is similar to that of Germany but below the OECD average (8%) and much lower than that of the United States (12%) and the United Kingdom (9%).

Instruments in support of business-sector innovation

Fiscal incentives

Over the past two decades, OECD countries have increasingly employed tax incentives for R&D. The Netherlands was among the first countries to introduce such instruments in 1994. The main instruments are the WBSO, the recently established RDA and the Innovation Box. The total budget for the tax credit/allowance (WBSO/RDA) was EUR 1 073 million in 2013 and EUR 1 066 million in 2014. The structural use of the Innovation Box in budgetary terms is estimated at EUR 625 million.

WBSO. The tax credit for R&D (WBSO) is the largest business innovation policy instrument in the Netherlands. It was established in 1994 and was modified over time following evaluations. It aims to promote innovation in firms by reducing taxes on labour costs of R&D personnel. The total budget for the WBSO was EUR 698 million for 2013. Actual use (budget depletion) was EUR 731 million in 2012 down from a peak of EUR 915 million reached in 2011, twice the volume of 2008 (data from the Netherlands Enterprise Agency, RVO). In 2014 the budget is estimated to increase to EUR 764 million and then to decline to around EUR 650 million in 2015. In 2012, the tax reduction corresponded to 42% of the first EUR 110 000 of R&D labour costs (60% for firms under five years old) and 14% for additional R&D labour costs. The tax reduction has a ceiling of EUR 14 million per calendar year. In 2009 and 2010, the tax reduction shares were temporarily increased to promote R&D expenditure during the economic crisis. The number of WBSO user companies increased by 8.2% from 2011 to 2012, mainly in non-top-sectors domains. Of these, 97% were SMEs, which accounted for 73% of the programme budget.

According to the evaluation of the WBSO programme covering 2006-10 (EIM, 2012), the scheme has helped to promote business R&D, a finding that is consistent with an earlier evaluation (Poot et al., 2003). Econometric estimates contained in the evaluation suggest that, by reducing R&D wage costs, the WBSO has had a positive impact on private R&D expenditure. Though the method does not conclusively show a causal relationship between the amount of tax relief and additional private R&D expenditures, it finds that on average, each euro of WBSO tax reduction was accompanied by 1.77 euros of private R&D (a measure commonly referred to as average "bang for the buck"). The evaluation further estimates that about 55% of the private R&D would likely have taken place regardless of the WBSO (EIM, 2012, p. 113). In addition to direct positive effects, there were indirect positive effects on innovation, such as increases in the share of turnover due to new or developed products and improvements in labour productivity. Moreover, participants reported that the WBSO had helped them take more risks, perform more R&D themselves, improve R&D planning and better absorb external knowledge, particularly in smaller firms (EIM, 2012).

However, the latest evaluation also showed that there are decreasing returns (captured by extra R&D generation) as the average share of tax reduction increases. The government therefore decided to decrease the tax benefit from 60% to 50% for young firms and from 42% to 35% for other companies. The first tax bracket was also increased from EUR 110 000 to EUR 250 000. Several evaluations of the WBSO (Lokshin and Mohnen, 2009; Brouwer et al., 2002; and Poot et al., 2003; as well as EIM, 2012) have shown that this measure is particularly beneficial to SMEs. This is due to its design, notably the ceiling and the fact that the first bracket of the tax credit is more generous.

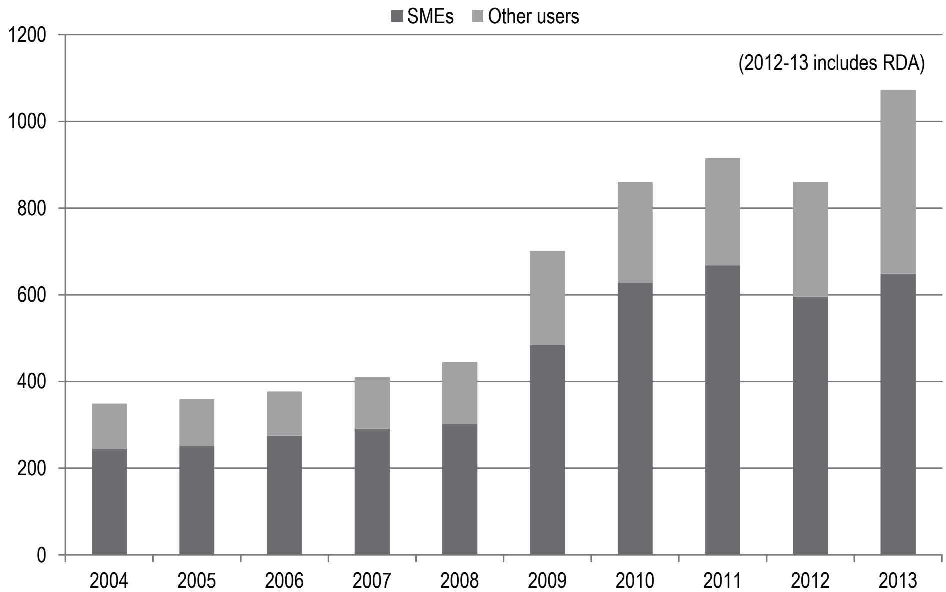
RDA. The research and development allowance (RDA) was introduced in 2012 to promote firms' investments in innovation. It allows firms to deduct investments in R&D equipment and exploitation costs. In this sense, it complements the WBSO, by offering tax credits for R&D investments other than those related to human resources. The budget depletion (allowance capitalised by enterprises) for the RDA was EUR 130 million in 2012 (information provided by Netherlands Enterprise Agency, RVO, 2014), the available budget is EUR 375 million in 2013 and EUR 302 million for 2014. In 2012 the tax relief corresponded to 40% of declared R&D expenditures and was increased to 60% after 2013. In 2012 top-sector firms claimed 72.8% of the budget of this programme. The share to SMEs is higher in non-top-sector domains (57.2% of the RDA budget allocation to SMEs) than in top sectors (32.5%).

Combined support through WBSO and RDA increased in 2013 (Figure 5.4). While the share of larger firms in total WBSO allowances has changed little over time, they have benefited especially from the introduction of the RDA. As a result larger firms accounted for a considerably larger share of total R&D tax allowances in 2012-13 than previously. Moreover the average size of their allowances increased considerably in recent years, from around EUR 200 000 in 2008 to over EUR 300 000 in 2010-11 and to similar levels since the introduction of the RDA (Figure 5.5).

Innovation Box. The Innovation Box is intended to secure and strengthen the Netherlands' position as an innovative, competitive economy. The Innovation Box offers to innovative businesses a preferential tax rate of 5% for income on "intangible assets" (hereafter: "intangible properties") that are self-developed (excluding trademarks, logos and other similar assets). Furthermore, the Innovation Box is applicable to some types of intangible properties only. These are (i) self-developed intangible properties protected by a patent granted to the taxpayer, and (ii) self-developed intangible properties that result from a qualifying R&D project for which a so-called "R&D statement" has been obtained from the Dutch authorities. Qualifying projects include development projects, technical or scientific research activities, analysis of technical feasibility of R&D projects, development of software, and process-oriented technical research.

Figure 5.4. WBSO and RDA, budget depletion to SMEs and other users, 2004-13

EUR millions

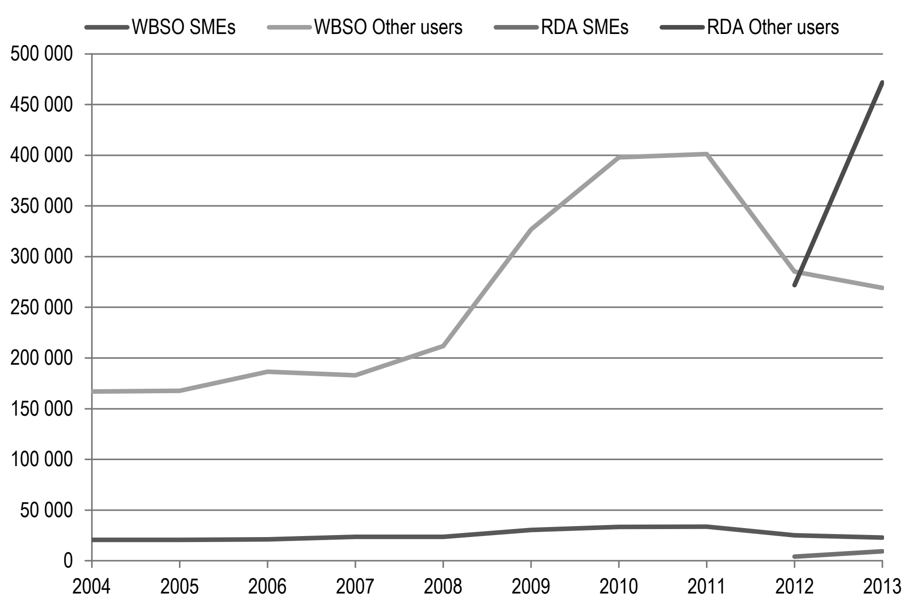


Notes: Allowance capitalised by enterprises. Allowance capitalised by self-employed persons excluded (not available). Based on number of enterprises including self-employed persons that have received an allowance right from the WBSO- and/or RDA-programme. Rights are not always capitalized by enterprises. Figures for 2013 are based on available annual budget, not budget depletion. Available WBSO-budget for self-employed persons (EUR 8 million) included.

Source: OECD, based on Netherlands Enterprise Agency, WBSO/RDA programme, 15 April 2014.

Figure 5.5. WBSO and RDA, average size of allowances (budget depletion) to SMEs and other users, 2004-13

EUR



Notes: See notes to Figure 5.4.

Source: OECD, based on Netherlands Enterprise Agency, WBSO/RDA programme, 15 April 2014.

The Netherlands introduced the Innovation Box in 2010. The Patent Box that had been introduced in 2007 was capped at the point at which the income from the intellectual property (IP) exceeded four times the cost of developing the invention. The cap was removed when the Innovation Box was introduced in 2010. Intangible assets developed by another party for the risk and account of a Dutch taxpayer also qualify for the Innovation Box. In this case the taxpayer should have the capability of managing the IP and the R&D work. Criteria that play an important role in determining whether the taxpayer qualifies for the Innovation Box are: having the expertise regarding the IP, being responsible for making relevant decisions, planning, budgeting, monitoring the R&D process, adjusting the scope of the R&D work etc. The Innovation Box does not apply to acquired IP; it only applies to the extent that the further development by the taxpayer leads to a new, self-developed intangible property.

The Innovation Box means that the tax regime for IP exploitation in effect in the Netherlands is quite generous in comparison to that of other European countries: the tax rate *for qualifying income* is 5% (it was 10% until 2009), which makes it less generous only than those of Malta (0%), Cyprus (2%) and Lichtenstein (2.5%), although it should be noted that not only tax rates are relevant, but also the tax base. Although the instrument is not budgeted, the structural use of this instrument is estimated at EUR 625 million (Patent Box until 2009: EUR 370 million). Although several countries have introduced similar instruments, there is no general consensus regarding their effectiveness (see Box 5.3). A formal evaluation is scheduled for 2015.

Box 5.3. "Patent Box" schemes in international perspective

Griffith et al. (2012) simulate the effects of patent box schemes across countries. They predict that in the Benelux countries and the United Kingdom, such schemes will not introduce benefits in the system since it will not be possible to attract extra income to compensate for the lower tax rate. In addition, their findings show that revenue losses increase when other countries introduce a patent box. Some of the general criticisms regarding patent box schemes relate to the fact that they tend to target the income of successful projects (the ones resulting in patents or other profitable R&D outcomes) rather that the underlying research and therefore do not increase the will to undertake newer and riskier research. In this respect they tend to be less effective in promoting R&D than more targeted R&D tax incentive schemes. This is true in particular when the tax incentives apply only to the final and commercial phase of R&D and do not require undertaking innovation-related activities in the country. For example, Ireland removed some tax incentives in 2010 because they did not have the desired effect on R&D investments. Patent box schemes may introduce distortions into firms' decisions (particularly those of multinational enterprises) to locate R&D activities and to declare the income generated by IP on the basis of the generosity of tax regimes. To be more effective, patent boxes need to be carefully designed and coherent with other policies that address the innovation system in general, such as investments in higher education, basic research and innovation so as to promote innovation spillovers from patenting firms to the system more generally.

Source: Griffith R., H. Miller and M. O'Connell (2012), "Corporate tax and the location of intellectual property", *CEPR Discussion Paper* No. 8424.

Access to finance (loan and loan guarantees)

In addition to a wide variety of credit support mechanisms available to businesses for various types of investment [see OECD (2014b) *Economic Survey of the Netherlands]*, the Dutch government has sought to ease the availability of credit for innovation-related investments. This has come as a response to the tight credit conditions since the beginning of the financial crisis, especially for SMEs (see Chapter 2). The instruments vary according to the target groups (small or larger firms) and the stage of financing or venture capital services provided (seed funding, venture capital, later-stage venture capital, etc.).

SME+Innovation Fund. The SME+Innovation Fund was created in 2012 to increase the availability of venture capital for SMEs. Its total budget for 2013 was EUR 165 million but will be reduced to EUR 96 million in 2014 and EUR 58 million in 2017 (Ministry of Economic Affairs, 2013c). It has three pillars:

- The *innovation credit* supports the development of high-risk innovative projects. If successful, companies using the innovation credit pay back the loan, if not, the credit is converted into a grant. The minimum credit was increased from 2012 to 2013 to facilitate the access of small companies to this scheme. The available budget (in common with the SME loan guarantee scheme, see below) was not fully utilised in 2012. In that year, the volume of outstanding loans was EUR 53 million (Ministry of Economic Affairs, 2013b), or approximately 55% of the available resources. This happened despite a 50% increase in applicants, as the quality of applications did not meet the selection requirements. A recent evaluation showed that an innovation credit ensures that the wage bill for R&D is on average 68% higher than it would have been without it (de Jong et al., 2013). Econometric estimates suggest that one extra euro of innovation credit resulted in an increase by 1.22 euro in total R&D wages and by 1.82 euro in total R&D expenditures. The evaluation also identified evidence that users of the innovation credit are more successful in terms of patent applications and job creation than companies whose applications were rejected. Importantly, compared to rejected applications, awarded projects are less likely to fail, which suggests that the stringent evaluation regime more than compensates for the potential perverse incentives introduced by the conversion of failed projects into grants.
- The *SEED capital* targets high-technology or creative entrepreneurs and provides public venture capital investment funds. Over 2005-12 the fund invested EUR 138 million (Ministry of Economic Affairs, 2013b).
- The *fund-of-funds* was created in 2013 with a budget of EUR 150 million (of which EUR 50 million from the EU). It is managed by the European Investment Fund, together with the Regional Venture Capital Company of the Eastern Netherlands. It focuses mostly on high-growth innovative enterprises in need of later-stage venture capital.

SME loan guarantee scheme (BMKB). BMKB gives a guarantee to banks that provide loans to SMEs. This allows SMEs to borrow more than they could without the scheme. In 2014, the guarantee for SMEs will be extended to cover 67.5% of the loan (up from 45%) for a maximum of EUR 200 000 per firm. In 2012, the BMKB budget was EUR 705 million and generated a total of over EUR 1.5 billion in loans (Ministry of Economic Affairs, 2013b). In that year, this guarantee scheme (like other guarantee schemes) was less used than in previous years: less than 70% of the available budget was used. This was partly due to the economic recession. Around 14.6% of beneficiaries are in the top sectors and receive around 21% of the loan budget.

Growth facility scheme (RG). This is another instrument to promote access to finance (venture capital) for SMEs. It provides a guarantee to funders for 50% of the total amount of the loan. The term of the guarantee is 12 months. Again, less than 26% of the available budget was used in 2012. The total available budget for that year was EUR 50 million (Ministry of Economic Affairs, 2013b).

Business loan guarantee scheme (GO). This scheme aims to facilitate access to financing for large and medium-sized firms in the Netherlands. Since 2013, capital providers receive a 50% loan guarantee from the government under this scheme. The guarantee lasts for a maximum of eight years. The budget for the scheme amounted to EUR 329 million in 2012 (Ministry of Economic Affairs, 2013b). Once again, this instrument was used less than in pre-2012 years, with only 31% of the budget allocated.

Dutch Investment Agency (NII). In 2013 a decision was taken to establish the Dutch Investment Agency to promote the availability of funding for firms. It will be formed in co-operation with pension funds, insurance companies and banks. NII will focus its interventions on social challenges such as health care, energy, infrastructure, housing and regional development initiatives. Its core tasks will be to pool knowledge, standardise propositions, evaluate and select projects, and provide sufficient scale and diversification of investments. The NII will act as an intermediary to help attract long-term funding from institutional investors and is expected to have a broad mandate in a wide range of sectors and investment categories (OECD, 2014b).

Microfinancing by Qredits. Qredits is a public-private partnership between Dutch banks and the Ministry of Economic Affairs, the Ministry of Social Affairs and Employment, and the Fund "Werken aan Wonen" (Working on Housing). It operates as a non-profit organisation, delivering micro-finance services in the Netherlands. Qredits provides microcredit loans up to EUR 150 000 and business coaching services. The budget for micro-financing was recently increased to EUR 30 million.

Demand-side instruments

Over the last decade there has been increasing interest in demand-side instruments to promote innovation in OECD countries. This reflects both a growing awareness that supply-side policies alone have not sufficiently promoted innovation and the fact that pressures on government spending show the need to promote innovation by other means.

Small Business Innovation Research Programme (SBIR). Inspired by the well-known US programme, SBIR uses public procurement to fund innovation projects that address social challenges. It specifically targets SMEs but large companies can also apply. The general objectives of the SBIR are to address social issues, to strengthen the innovative capacities of businesses, particularly SMEs, and to contribute to the production of knowledge (Ministry of Economic Affairs, 2010). It has three variants: the departmental SBIR concerns pre-commercial procurement and corresponds to the first two objectives; the TNO-SBIR covers all three objectives and emphasises exploitation of knowledge developed by TNO; and the STW valorisation grant focuses on university researchers who aim to start a business or otherwise transfer knowledge to businesses (Technopolis, 2010). The first two variants award contracts to companies, the third variant awards grants.

In spite of their different logics and positions in the policy mix, all SBIR components finance the early phases of a project's development but not the subsequent commercial exploitation. The first phase involves a feasibility study. If the results are positive, the R&D phase follows. Themes covered by SBIR include green materials, energy efficiency and clean energy. The programme, promoted by the Ministry of Economic Affairs with the involvement of other ministries, started in 2004 and it is implemented by Agency NL. SMEs can apply for feasibility grants (up to EUR 50 000) and subsequently for R&D grants (up to EUR 450 000). The SBIR budget increased from EUR 3.5 million in 2006 and EUR 7.45 million in 2008 to EUR 32 million in 2010. Its central government component has been reduced since[17] A 2010 evaluation of the programme concluded that SBIR is effective (Technopolis, 2010) but highlighted the need for further monitoring and coaching in the market implementation phase and for better co-ordination with other national and regional instruments.

Innovative Procurement Urgent. This recently established instrument aims to promote innovation from a demand-side perspective. It was launched by the Ministry of Economic Affairs, but its execution will also involve other ministries. The goal is to devote 2.5% of the government budget to innovation-friendly public procurement. It is project-based and has so far selected 27 projects. The projects must focus on a social challenge.

Top sector-specific instruments

In addition to the above-mentioned generic instruments, two instruments specifically address firms in the top sectors. These seek to promote innovation in the top sectors as well as public-private co-operation.

TKI allowance. The TKI allowance scheme promotes the development of public-private R&D consortia in each top sector. TKI allowances are implemented as follows: the government adds 25% of the total amount provided by business-sector actors as co-funding. In 2013 a total of EUR 319 million of private contributions resulted in a total TKI allowance of EU 83 million. For SMEs, the government co-funds 40% for the first EUR 20 000 contributed by SMEs.

SME innovation support top sectors (MIT). Introduced in 2013, the MIT scheme promotes the participation of SMEs in top-sector valorisation initiatives. MIT uses various instruments: collaborative R&D projects, feasibility studies, innovation vouchers, hiring of experts, networking and coaching. In 2013 the total budget for this programme was EUR 23 million (Ministry of Economic Affairs, 2013c), but it was not possible to fund all applications with the available budget. Table 5.7 shows the budget allocation for 2014. Table 5.8 summarises the business innovation support instruments discussed above.

Table 5.7. MIT 2014 budget allocation by top sector and instrument

Opening	**15 April – 12 May**						**3 June – 22 September**
Applicant's	**MKB (FCFS)**				**TKI (FCFS)**		**MKB (tender)**
Instrument → Top sector↓	*Feasibility studies*	*Vouchers*	*Hiring staff*	*IPC*	*Network activities*	*Innovation brokers*	*R&D co-operation*
Horticulture…	750 000				50 000	250 000	950 000
Agri&food	478 400						1 913 600
Water	1 002 900 (vouchers according to feasibility study)				100 000		897 100
Life sciences and health	600 000				100 000	200 000	1 100 000
Chemistry	550 000		(according to feasibility study)		100 000	150 000	1 216 500
Bio-based	400 000				100 000	150 000	1 350 000
HTSM/ICT					200 000		3 800 000
Energy	1 200 000				100 000	200 000	500 000
Logistics	900 000				100 000	100 000	900 000
Creative Industries		860 000		(according to vouchers)	100 000	100 000	940 000
General budget (for all top sectors)							8 000 000

Source: RVO (2014), "MKB-innovatiestimulering Topsectoren (MIT)", www.rvo.nl/subsidies-regelingen/mkb-innovatiestimulering-topsectoren-mit.

Table 5.8. Business innovation funding instruments overview, 2014 or latest year

Main instrument	Annual budget (or annual average) EUR millions	Additional public [source] or private funds leveraged EUR millions	Modality of delivery (e.g. direct funding, fiscal incentives, loan or loan guarantees)	Policy objective	Target population (sector, size, age, innovative behaviour)
WBSO	764	Private funds estimated* at around 1 390	Tax credit	R&D workers	All
RDA	302	n/a	Tax credit	R&D, non-labour costs	All
TKI allowance	102 (83 in 2013)	319 expected private funds (2013), 500 public funds aligned	Co-financing, 25% supplement (40% for first EUR 20 000)	Joint programming	Top sectors only
MIT (SME innovation support Top Sectors)	30	n/a	Choice of instruments** under discretion of top teams	SME participation in valorisation	Top sectors only
MKB+ (SME+ Innovation Fund) consisting of:					
Sub-instruments: Innovation credit	86.5 (2013)	n/a	Loan if successful, converts to a grant if project fails	Finance for high-risk innovation	SMEs, especially start-ups
Sub-instruments: SEED Capital	21.5 (2013)	n/a	Venture capital	Finance for innovation	High-technology entrepreneurs/SMEs
Sub-instruments: Fund-of-funds	100	50 from EU	Venture capital	Finance for innovation	High-growth innovative firms
Innovation Box	625		Tax credit on profits from innovation	R&D investments	All
BMKB (*SME Loan Guarantee Scheme*)	705 (2012)	795	Loan guarantees (67.5% of loan, up from 45% in 2013)	Facilitate credit, increased during the crisis	SMEs (14.6% in the top sectors receive 21% of budget)
NII (Netherland Investment Institution)	[predecessor Syntens had 30.5 in 2013]	n/a	Transfer of authority (agency)	Promote the availability of funding and facilitate investment	All

Table 5.8. Business innovation funding instruments overview, 2014 or latest year *(continued)*

Main instrument	**Annual budget (or annual average)** EUR millions	**Additional public [source] or private funds leveraged** EUR millions	**Modality of delivery** (e.g. direct funding, fiscal incentives, loan or loan guarantees)	**Policy objective**	**Target population (sector, size, age, innovative behaviour)**
Microfinancing (by Qredits)	n/a	30 (including private finance)	Micro-loan and business coaching	Finance for innovation	SMEs
Growth facility scheme (Regeling Groeifaciliteit)	50 (2012)	50	Loan guarantees (50% of loan)	Facilitate venture capital for SMEs	SMEs
Business Loan Guarantee Scheme (Garantie Ondernemings-financiering, GO)	329 (2012)	329	Loan guarantees (50% of loan)	Facilitate credit	Large and medium-sized firms
SBIR (Small Business Innovation Research Programme)	6.3 (2013) from central government	n/a	Project funding for public procurement	Societal challenges, demand stimulation, valorisation of public knowledge	SMEs, but partly open to large firms
Innovative Procurement Urgent (Inkoop Innovatie Urgent)	n/a	n/a	Project funding for public procurement	Societal challenges (demand stimulation)	n/a

Notes: * Estimated from public budget using the 1.77 ‘bang for the buck’ estimate provided in EIM (2012), p. 12; ** Choice of instruments includes collaborative R&D projects, feasibility studies, knowledge vouchers, hiring of experts, networking activities and innovation brokers.

Source: Ministry of Economic Affairs (2013), “Summary Chart Enterprise Policies” (unpublished), ERAWATCH website, Netherlands Enterprise Agency, RVO (2014), WSBO/RDA programme, 15 April 2014and correspondence with Ministry of Economic Affairs.

Business innovation policy mix

Current challenges and the policy mix

Dutch innovation (and industrial) policy has high aspirations. The document that launched the top sectors (Ministry of Economic Affairs, 2011) stated the Netherlands' ambition to be among the top five knowledge economies globally. The Netherlands is well placed to fulfil this ambition, particularly because of the very high quality of its human resources. There are nonetheless important challenges, most prominently the long-standing low levels of business R&D.

The difficulties faced by Dutch exporters in the emerging BRIC markets feature prominently among the rationales behind the top sectors. This concern resonates strongly with the business sector. The findings of a government-commissioned business survey are illuminating:

> "According to the respondents, the difference between the share of Dutch exports to the BRIC countries and the EU average is not to be blamed on failing Dutch government policy. They believe European competitors to have easier access to the BRIC markets because they are larger and more internationally active, their products better suit the demand of the BRICs, and they can deliver at lower prices." (de Jong and van Winden, 2011)

Better performance on innovation can help address the insufficient demand for Dutch products and poor cost-competitiveness in these markets. Raising international competitiveness is not the only challenge. In light of demographic shifts and environmental challenges, innovation – much of it performed by firms – is set to make a crucial contribution. Productivity improvements in some of the Dutch services sectors could have a lasting impact not only on the economy but more broadly on Dutch society.

Evidence presented in Chapter 4 suggests that, while the Dutch business sector is very innovative overall, aspects of its innovation performance fall short of the world's leading innovation systems. In particular, a comparatively large part of the business sector (as reflected in R&D intensity and in levels of industry-university collaboration compared to business sectors in other advanced systems) does not appear to engage in new-to-the world innovation. In light of the challenges and the diagnosis of business innovation performance, policy effort would need to:

- increase the pool of innovating firms and intensify business innovation effort of all kinds;
- raise the ambition and scope at the global level for a greater share of business innovators, which will inevitably require a greater emphasis on R&D to match the levels of other advanced innovation systems;
- foster diversification into product and market segments of rising global demand, which will partly occur as a long-term result of a more R&D- and more innovation-intensive economy.

This section considers how well the current policy mix fits these tasks. Table 5.9 presents the instruments deployed in support of business-sector innovation and the development needs of various parts of the business sector according to their innovation behaviour. In the Netherlands, as in other advanced innovation systems, the majority of firms systematically engage in innovation that is at least new to the firm (Table 5.9, Column A). A sizeable number, perhaps a majority, also introduce innovations that are new to the market (Column B). The current policy thrust appears focused on Column B. While the available instruments and the needs of firms overlap considerably in Column C, the scale, distribution and some of the characteristics of the current policy effort could be better attuned to firms that have not yet made the transition to new-to-the-world innovation. These issues are discussed below.

Table 5.9. Business support policy mix according to current capacity and further development needs

Capacity building / development stage →	**A**. […from no innovation activity to innovation that is]	**B**. […from primarily new-to-the-firm to innovation that is]	**C**. […from new-to-the-firm and new-to-the-market to innovation that is]
↓Policy tasks↓	*new-to-the-firm*	*new-to-the-market*	*new-to-the-world*
1. *Increase the pool of innovators*	WBSO, RDA, micro-financing	WBSO, RDA; MKB+, BMKB (small firms); TKI, MIT, RDA+ (Top Sectors only)	WBSO, RDA (only partially due to small scale); Innovation Box; MKB+, BMKB (small firms only); TKI, RDA+ (top sectors only)
2. *Increase the intensity of innovative effort*	WBSO, RDA, Growth Facility; MKB+, BMKB	WBSO, RDA; MKB+, BMKB (small firms); TKI, MIT, RDA+ (Top Sectors only); Business Loan Guarantee Scheme	WBSO, RDA (only partially due to small scale); Innovation Box; MKB+, BMKB (small firms only); TKI, RDA+ (top sectors only)
3. *Diversify by extending the range of innovation modes and fostering collaboration*	WBSO, RDA	TKI, MIT; RDA+ (Top Sectors only); SBIR (very partially due to small scale)	TKI, MIT; RDA+ (Top Sectors only); SBIR (very partially due to small scale), EUREKA

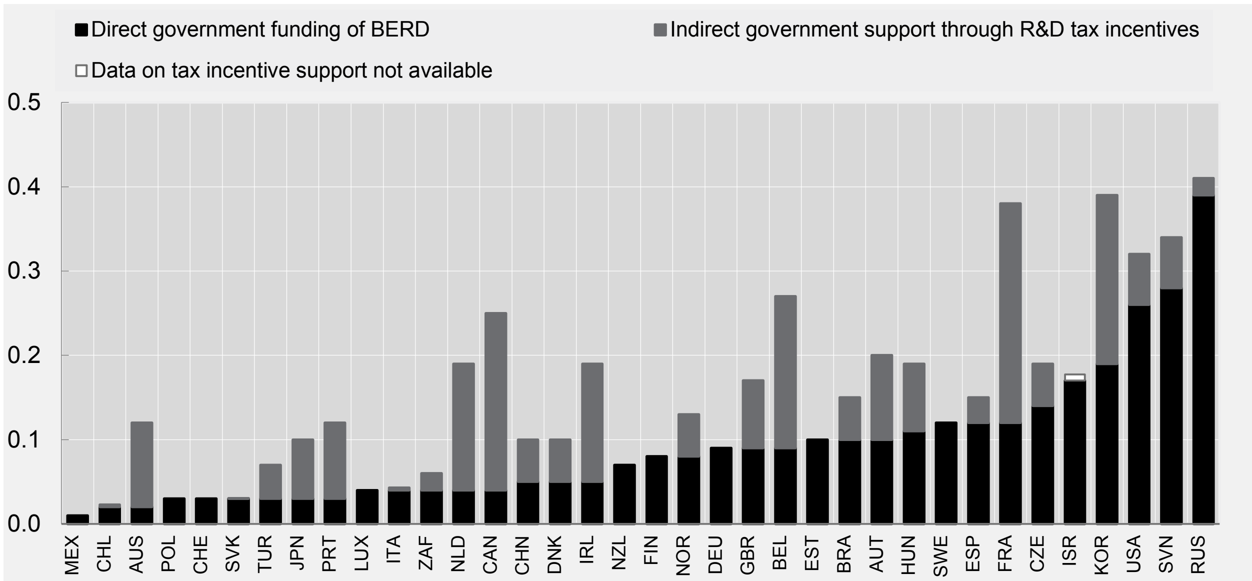
Source: OECD Secretariat, drawing on contributions by Martin Bell, SPRU, University of Sussex.

Balance between tax incentives and direct funding

The Netherlands places more emphasis on tax incentives than on direct funding instruments than most other OECD countries except Canada and Australia. Ireland is the country that most resembles the Dutch situation (Figure 5.6). Over USD 1 billion in support for business R&D was channelled through tax incentives in 2011. WBSO and RDA provide relief for inputs to innovation and the Innovation Box provides relief for licensing and commercialisation revenues. SMEs use and benefit from the schemes extensively. In an international comparison, Dutch R&D tax incentives are much more generous to SMEs than to larger firms (Figure 5.7). Evaluations of WBSO (the main and older instrument) have been generally positive and policy design has been responsive to their findings.

Figure 5.6. Direct and indirect government funding of business R&D and tax incentives for R&D, 2011

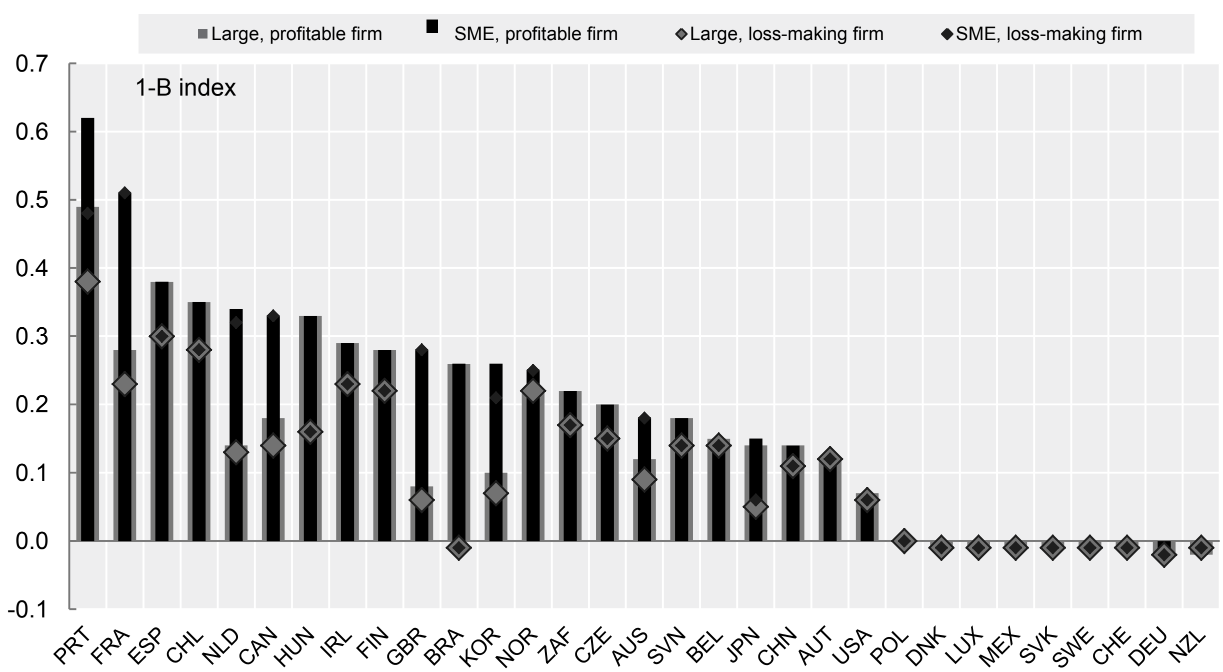
% of GDP



Note: Data on indirect support not available for Israel. This is an experimental indicator. International comparability may be limited. For more information, see www.oecd.org/sti/rd-tax-stats.htm.

Source: OECD (2013a), *OECD Science, Technology and Industry Scoreboard 2013: Innovation for Growth*, OECD Publishing.

Figure 5.7. Tax subsidy rates on R&D expenditures, 2013



I-B-Index, by firm size and profit scenario

Source: OECD (2013b), "Measuring Tax Incentives", www.oecd.org/sti/rd-tax-stats.htm.

In common with direct support for business R&D, tax incentives can be justified as a response to the market's tendency to devote fewer resources to R&D than would be socially desirable. They can be more advantageous than direct funding in that they allow firms to decide which R&D projects to finance. In the Netherlands the potentially lower implementation costs of tax incentives were also an important factor in the decision to shift the balance in their favour.

Tax incentives, however, have disadvantages as well. OECD analysis has shown that tax credits, depending on how they are designed, may favour less dynamic incumbents at the expense of dynamic young firms (Box 5.4). In addition, there is concern that some multinational enterprises (MNEs) may use cross-border tax planning to exploit international asymmetries in the treatment of costs of and income from R&D, leaving firms without such opportunities at a disadvantage. Importantly, tax incentives may erode the tax base. By contrast, direct funding can be better targeted at parts of the business sector that need support, at a wider range of firm capabilities and at the behaviour that needs to change (e.g. to foster capacity development, to raise the scope and ambition of innovation activity or to get firms to collaborate). For these reasons, many OECD countries are currently re-thinking the extent and conditions of the use of tax incentives.

The Dutch tax incentives appear to meet most of the principles of good policy design. In particular, there are different brackets, there is a ceiling, there are only small differences in their generosity to profitable and non-profitable firms, and WBSO is regularly monitored and evaluated. The principal question about tax incentives in the Netherlands is not about their design but about the extent of reliance on them and their fitness for purpose, given the diverse challenges involved in raising not only the intensity but also the ambition of firms' innovation activity.

An additional argument relates to the effect of a focus on tax incentives on the *place* and *timing* of decision making with respect to innovation. A commonly mentioned issue in the Netherlands is that the benefits sometimes accrue to a part of the firm (e.g. the financial department) that may not be involved in innovation planning. More generally, greater reliance on tax measures may weaken the position of innovation decision makers in the inevitable negotiations over budget allocations that take place both within government and within companies. It also does not help that the benefits from tax credits accrue at least a year after decisions are made about the design and scale of specific innovation projects. It may be because of this that evidence from international evaluations of R&D tax incentives suggests that behavioural additionality can be low. For example, most companies surveyed in the context of an evaluation exercise of the UK R&D tax credit scheme suggested that it had little if any effect on decisions to conduct individual pieces of R&D (HRMC, 2010).

A specific drawback of the reliance on tax incentives is that these do not permit distinctions in the type of R&D and innovation supported. With such instruments, it may be difficult to support longer-term and riskier innovation activities, but these are the kinds of activities which markets typically do not undertake independently, which cannot fully be covered by public research, but which hold great promise of social and economic impact. In that respect tax-based instruments do not seem as well suited to changing the behaviour (e.g. to encourage collaboration with knowledge institutes), and raising the ambition of R&D conducted in companies, as some forms of direct finance, particularly those that involve rigorous project-level evaluation and selection.

Box 5.4. International experience with tax incentives for R&D

R&D tax incentives have proliferated and become more generous but they may create an uneven playing field that leaves new sources of growth unexploited.

R&D tax incentives have proven popular largely because exemptions from international agreements (e.g. in the WTO, EU) make R&D subsidies one of the few ways that governments can help domestic firms improve competitiveness without direct state aid. Governments also support R&D to achieve specific R&D/GDP intensity targets, to stimulate productivity growth and offset the decline in R&D associated with the economic crisis, as well as to encourage firms that perform R&D to locate domestically with a view to encouraging knowledge spillovers.

These potential benefits have led many governments to increase the generosity of R&D tax incentives in recent years. Over 2006-11, about half of the 23 countries for which complete data are available increased their generosity, with R&D tax support rising by almost 25% in some countries.

This may underestimate the increasing generosity of R&D tax incentives. Without any changes in policy, the value of R&D tax incentives would have been expected to decline during the crisis, in part because fewer firms were profitable (and thus unable to benefit from non-refundable tax credits), and in part because R&D itself declines during economic downturns.

Tax incentives subsidising R&D are considered attractive because they are market-based and seen as more "neutral" than direct support. But business R&D is heavily concentrated in MNEs: the top 1 500 firms investing in R&D account for almost 90% of total business expenditure on R&D worldwide. While MNEs are an important source of knowledge spillovers and productivity improvements, the tax system should not create a competitive disadvantage for domestic "stand-alone" firms that do not have cross-border tax planning opportunities.

More generally, MNEs consider the bundle of measures at the corporate tax level; this includes expenditure-based measures, such as R&D tax incentives, as well as income-based policies, such as "patent boxes". Intellectual assets generated by R&D, such as patents, may be developed in one country, held in another and used for production in a third. When these assets are shifted among affiliates of an MNE in different locations, it is hard to value them because of the lack of a market to gauge an arm's-length price. All of this has made it easier for MNEs to shift profits among tax jurisdictions and harder for tax authorities to establish where profits have been made.

Fundamental changes to the international tax system are needed to address the gaps and loopholes that enable MNEs to achieve double non-taxation. Ensuring that taxable income can no longer be artificially segregated from the activities that generate it is a key objective of the OECD's Action Plan on Base Erosion and Profit Shifting.

It may also leave new sources of growth unexploited. Evidence from 15 OECD countries over 2001-11 suggests that young businesses, many of which are knowledge-based-capital-intensive, play a crucial role in employment creation, regardless of their size. Over this period, young firms (five years of age or less) accounted for about 20% of total (non-financial) business-sector employment but generated almost 50% of all new jobs created.

Moreover, during the economic crisis most job destruction was due to downsizing of large mature businesses, while most job creation was due to young enterprises. In the recovery, young firms have also been crucial for job creation in many countries. As a result, policy makers should ensure that any policy package to foster innovation includes measures targeted at young firms as well as those aimed at larger firms, including MNEs. For R&D tax incentives, provisions for cash refunds and carry-forwards can help diminish the inherent bias against new firms.

…/…

Box 5.4. International experience with tax incentives for R&D *(continued)*

The production, use, economic ownership and taxation of knowledge-based assets have become increasingly decoupled in the latest wave of globalisation. As a result, designing cost-effective tax policies to promote innovation in a globalised economy in which MNEs and knowledge-based assets play major roles has become more challenging. While each country is unique, several policy implications can be derived from new OECD work on tax policy and knowledge-based capital.

R&D tax incentives should be designed to meet the needs of young, innovative "stand-alone" firms without cross-border tax planning opportunities.

Domestic "stand-alone" firms that perform R&D may be at a competitive disadvantage *vis-à-vis* MNEs unless there are other measures, such as ceilings and differentiated rates, that ensure a level playing field. Young firms may also benefit less if they have not yet generated taxable income to make immediate use of (non-refundable) R&D tax incentives. This may inhibit innovation and growth, as such firms have particular strengths as R&D performers (e.g. creation of radical innovations) and job creators, unless measures such as cash refunds, carry-forwards, or the use of payroll withholding tax credits for R&D-related wages are used. But care must be taken to ensure that tax relief is not so high that it hampers the process of creative destruction that is essential to a dynamic innovative ecosystem.

Policy makers should consider balancing indirect support for business R&D (tax incentives) with the use of direct support measures to foster innovation.

OECD analysis suggests that direct support measures – contracts, grants and awards for mission-oriented R&D – may be more effective in stimulating R&D than previously thought, particularly for young firms that lack the upfront funds to start an innovative project. It is important, however, that any allocation of direct support should not be automatic but based on competitive, objective and transparent criteria (e.g. by involving independent international experts in the selection process). More broadly, a well-designed and transparent system of direct support measures can complement the use of R&D tax incentives as it may help direct public funding to projects with high social returns.

Governments should ensure that R&D tax incentive policies provide value for money.

In many countries, overall tax relief for business R&D may be greater than governments intended when they designed the instrument. This may be compounded by the rising generosity of tax relief for R&D observed in recent years, the full cost of which is not always clear because R&D tax incentives are "off budget" as a tax expenditure. As a result, governments should undertake systematic evaluation of tax relief measures to assess the continuing validity of their rationale and objectives and whether their targeting and design remain appropriate. Important aspects of R&D tax schemes that require review include the scope of eligible R&D, the firms that qualify, the treatment of large R&D performers, as well as carry-back and carry-forward provisions. Governments should also focus on the policy package – including interactions and complementarities – as well as related fiscal measures concerning R&D workers to ensure that R&D tax incentives provide value for money.

The effectiveness of R&D tax incentives depends upon the broader regulatory environment and its stability over time.

OECD evidence shows that well-functioning product, labour and risk capital markets and bankruptcy laws that do not overly penalise business failure can raise the returns to investing in knowledge-based assets. OECD analysis also suggests that in countries that have experienced a large number of R&D tax policy reversals, the impact of R&D tax credits on private R&D expenditure is greatly diminished. It is therefore important not to tinker repeatedly with such policies so as to minimise policy uncertainty for firms.

Source: OECD (2013c), "Maximising the benefits of R&D tax incentives for innovation", www.oecd.org/sti/rd-tax-incentives-for-innovation.pdf.

Indeed, rigorous project-level evaluation and selectivity should be central to any approach to business innovation that seeks to raise the bar to the global level and to encourage longer-term, possibly riskier and therefore potentially higher-impact, innovation activities. This is of course already the case for smaller instruments such as the Innovation Credit, which have been subject to very stringent assessment not only of financial but also of technical feasibility, with impressive results (de Jong et al., 2013). There may be room for using changes in evaluation practice (e.g. by customising the criteria to include technical and scientific aspects of projects so as to raise ambition) even within the current tax-credit arrangements, particularly for the larger-sized tax-credit allowances. However, an assessment of the feasibility of such changes is beyond the scope of this review. If rigorous project-level evaluation cannot be meaningfully introduced under current arrangements then the impetus for a return to more direct forms of funding would be stronger still.

Balance between small and large firms

With few exceptions, SMEs seem well served by the current policy mix. The government closely watches the availability of finance for SMEs and has deployed a battery of measures to ease constraints, particularly during the recent crisis. If all forms of public support are considered, SMEs receive a greater share of government-financed BERD than their share in total Dutch BERD. SMEs receive considerable support in the form of R&D tax credits. For instance, SMEs obtain the majority of the WBSO. Tax credits appear to have increased awareness of innovation and enticed many smaller firms to engage in it. The MIT scheme in the top sectors, targeted specifically at SMEs, offers the opportunity to tailor interventions according to demand. However, as its current budget is small (typically EUR 2 million per top sector and per cross-cutting theme), there is little potential for changing the balance between direct and indirect measures.

Although SMEs needing upfront funds may find the reliance on tax credits problematic, loan mechanisms that cater to very small firms (such as microfinance), young innovative firms (SEED Capital, Innovation Credit) and venture capital (Fund-of-funds) may, to some extent, compensate for the lack of direct funding. However, take-up of these instruments and the loan guarantees is not very strong, as the shares of uncommitted funds shows. In addition, the limited re-introduction of the successful innovation voucher scheme in some of the top sectors, at the request of top-sector management, signals that latent needs for other types of innovation funding may exist. Co-ordination within the top sectors and potentially beyond represents an opportunity to find out more about specific bottlenecks in firm finance and introduce remedial action.

More immediately, it would be important to ensure that the policy mix also caters to firms taking their first steps in innovation (cell A.1 in Table 5.9), particularly SMEs, a sizeable minority of which (over 40% according to the Community Innovation Survey) still do not innovate. The current imbalance in favour of tax credits may constrain first-time innovators, which often require upfront, small-scale funding. The needs of these innovators are, on the whole, more likely to focus on design and engineering activities than on R&D. The positively evaluated but now abolished innovation voucher scheme probably played a key role in this area. In the present policy mix this role is partly taken up by the various loan support instruments. Given their strong links with industry, the universities of applied sciences (UAS) seem well placed to support the development of capabilities in firms that innovate for the first time. Current efforts to strengthen research and innovation activities in UAS appear well timed and could be explicitly linked to this purpose.

While rigorous project-level evaluation is appropriate for the overwhelming majority of public support to business innovation, a limited amount of small-scale, low-barrier (in terms of approval lead time and bureaucracy) direct funding can be useful for exploring a greater range of high potential, but somewhat more speculative ideas. A justification for this type of funding can be found in the statistical distribution of highly valuable innovations: it is extremely skewed and cannot be predicted by any measurable traits of innovation performers (Scherer and Harhoff, 2000, Silverberg and Verspagen, 2007). Innovation vouchers are an instrument that seems a good fit for this purpose. Some regions are offering innovation vouchers and their reintroduction in the MIT scheme is therefore welcome, though they could be usefully extended outside of the Top Sectors too.

A potentially important issue is the suitability of the current policy configuration to the development needs of other parts of the business sector, notably larger firms. Large firms are, on the whole, more likely to innovate and to devote substantial resources to R&D. However, as seen in Chapter 4, there are indications that the R&D deficit of the Netherlands with respect to other countries with advanced innovation systems is, rather unexpectedly, greater for large firms than for SMEs. The same pattern holds for collaboration with knowledge institutions. The deficit also has a sectoral dimension; it is particularly pronounced, for example, in services (again, relative to other advanced systems). As Table 5.9 shows, the current policy mix only partially covers the needs of these firms (cells C.1, C.2 and C.3). Because of the cap, the tax credits account for relatively small shares of the R&D budgets of larger firms. The additionality of the instrument is likely to be limited and alternative designs may focus resources on the parts of the business sector in which behaviour needs to change (e.g. to collaborate). At least for firms in the top sectors, additional support and help from knowledge institutions can be made available. However, there appears to be little in the current policy mix for intermediate-sized firms whose business falls outside the top sectors. It would be important for the dynamism of these sectors to fill this gap.

The role of the top sectors

The top sectors seem well suited to fostering co-ordination, identifying and amplifying "weak signals" of technological and market opportunities[18], and to bringing about the corresponding alignment of strategies and pooling of resources. Co-ordination of the kind that takes place within the top sectors may also be useful in bringing about lasting changes in behaviour, such as facilitating co-operation with knowledge institutions and raising the scope and ambition of business innovation, including by performing more R&D.

The involvement of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Netherlands Organisation for Scientific Research (NWO) helps to ensure scientific rigour. As science is a global endeavour, the involvement of KNAW and NWO may also be positive in terms of encouraging firms with experience in new-to-the-firm and new-to-the-market innovation to extend the scope and ambition of their activities at the global level. As mentioned earlier, however, and partly illustrated by the experience so far of Finland's strategic centres for science, technology and innovation (SHOKs),[19] this is not guaranteed. Suitable governance and co-ordination arrangements should aim to ensure that it is public research excellence, with its global perspective, that steers the orientation of business-sector innovation towards the frontier, while still improving the applicability of public research.

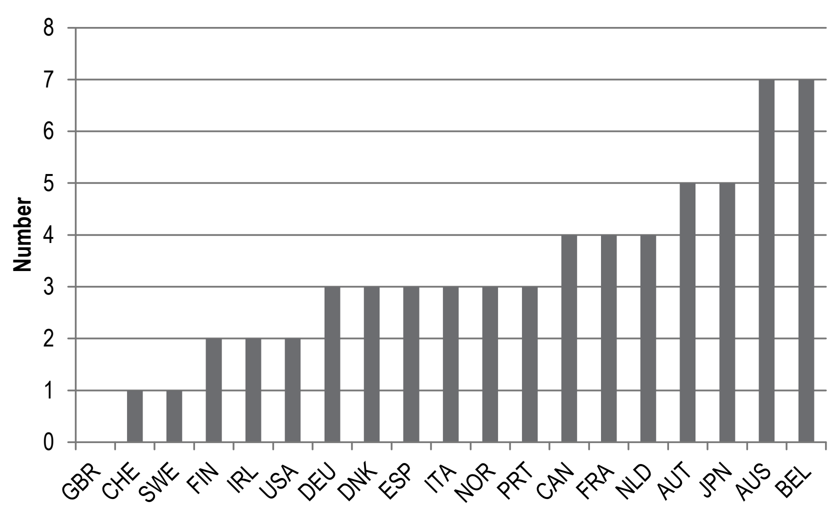
As with the tax incentives, however, the chief issue with the top sectors approach is less its design (the co-ordination problems and orientation risks discussed above notwithstanding) than the approach's position in the policy mix. As discussed in Chapter 4, the R&D intensity deficit appears higher for intermediate-sized firms and for firms in services (and in some other sectors), the parts of the business sector that were among the least likely to co-operate with universities and PRIs. The need for increasing the intensity, scope and ambition of innovation may therefore be greater in parts of the business sector that are not covered by the approach (such as, but not only, services) or whose coverage is not known (intermediate-sized firms)[20].

The need for stability

The long-term effectiveness of policy also depends on the stability of the policy regime over time (Guellec and van Pottelsberghe, 2003). In the Netherlands, changes in the policy mix to support the business sector have been frequent; this has been difficult for businesses. The changes in Dutch innovation policy have included both large-scale shifts in orientation (e.g. in the balance between generic and sector-specific support), in the way PPPs are organised, and in the modalities of implementation of the various funding instruments (Velzing, 2013; Hessels and Deuten, 2013). It is likely that much of the frequently cited concern with "red tape" actually refers to the considerable costs incurred by all actors in having to learn in relatively quick succession how the latest policy framework works. A rough measure of uncertainty in innovation policy (the frequency of reversals in R&D tax incentives) is presented in Figure 5.8. The Netherlands is at the upper end of the countries considered.

Figure 5.8. Number of reversals in innovation policy

Cumulative reversals in R&D tax policy, 1982-2008



Note: The figure uses a measure of uncertainty of R&D tax policy as the number of instances in which the B-index immediately reversed course (i.e. implements more generous R&D tax policy immediately after implementing less generous policy) over 1981-2008.

Source: Calculations by Westmore (2013), based on *OECD Science, Technology and Industry Outlook 2010*.

Changes in the policy mix have a cost. Paradoxically, frequent programme- or instrument-level evaluations and a responsive government (which are of course very welcome) may have contributed to the instability. In the future, the costs of the inefficiencies identified in evaluations of existing instruments would need to be balanced against the costs of potential changes not only in terms of administrative implementation, but also in terms of learning and transaction costs for all stakeholders, particularly entrepreneurs. This implies, and would be a natural by-product of the development of stronger, system-level evaluation (discussed above) to complement the already very strong instrument-level evaluation practices.

5.5. Nurturing innovation skills

Dutch higher education is undergoing profound reforms. These were first recommended by the Veerman Committee on the Future Sustainability of the Dutch Higher Education System (2010) and reinforced in the 2011 White Paper *Quality in Diversity – Strategic Agenda for Higher Education, Research, and Science*, which remains the government's blueprint for higher education reform. The background for the Veerman committee was the observation that the current, as well as the future, growth in student numbers puts strong pressure on the Dutch higher education system. Furthermore, it was acknowledged that the system was not flexible enough to meet the needs of students and labour markets, that drop-out rates were high (see Chapter 4) and, overall, that the university education system did not seem to serve the varied needs of students and the labour market. The main recommendation of the committee was to improve the quality and diversity of Dutch higher education through a threefold differentiation: in the structure of the system, in the profiles of institutions and in the range of programmes offered.

The Veerman Committee report received broad support from various stakeholder groups: higher education institutions, students, employer organisations, parliament and the government. The White Paper supported the recommendations of the Veerman report and advocated several changes:

- Collective and individual performance agreements with universities on education quality and study success, profiling and valorisation. These should result in reducing the number of education programmes on offer, reinforcing the relevancy of programmes to the labour market, developing focus areas in research, and enhancing the impact of research.
- A change in direction in the financing of higher education, with the introduction of a growing proportion of direct funding earmarked for "quality and profiling".
- Modifications of regulations to assure degree quality, success in studies, education quality and intensity, selection, differentiation in the programmes available, and funding.
- Support from the higher education sector for the government's top sectors approach.

Performance agreements

A key aspect of the White Paper is the introduction of multi-year performance agreements between the government and individual research universities and universities of applied sciences. The Association of Universities in the Netherlands (VSNU) and the Netherlands Association of the Universities of Applied Science (Vereniging Hogescholen) first signed collective strategic agreements with Ministry of Education, Culture and Science (and in the agricultural higher education sector, with the Ministry of Economic Affairs) that provided a framework for the *individual* agreements made by each university and the relevant ministry. Each university then signed separate performance agreements covering education quality and study success, profiling and valorisation. Such agreements, which are new to the Netherlands (Box 5.5 provides a short history of changes in university governance arrangements over the last two decades), mark a change in the relationship between the universities and the government: the latter is now more proactive in promoting its policy goals in the university sector.

Box 5.5. The changing governance arrangements of Dutch universities

The 1992 university bill covers both the academic universities (WO) and universities of applied science (UAS). It is still valid, but over the years, there have been incremental changes to the university system. For example, in 1997, the Dutch parliament accepted a new university bill abolishing the representative governance system in the universities, which had emerged in 1970 as a result of the political agenda of the 1960s and ensuing demands for democratic participation of junior academics, staff and students in university decision making (de Boer and Goedegebuure, 2001). Under this system, elected representative councils had a lot of power and effectively co-determined strategically important issues with the executive body. This system was regarded as cumbersome and inefficient and did not tend to take strategic decisions (File and Stensaker, 2006).

The 1997 Act strengthened the executive leadership *vis-à-vis* the representative councils. The executive board, which consists of three appointed members (including the rector), obtained nearly all power in both academic and non-academic matters. The board was accountable to a new supervisory body consisting of five lay members appointed by the minister for a period of four years. They are typically experienced people from the public and private sector, many of the latter from large firms, and provide a forum for direct contact and interaction with wider society and the economy (de Boer et al., 2010). At the faculty level, earlier disciplinary research and teaching units (*vakgroepen*) were abolished and most of their powers were given to newly appointed deans (CHEPS report, 2006). The old university and faculty-level representative councils were retained but became advisory with some limited powers. Half of their members represent the staff and half the students (de Boer and Goedegebuure, 2001).

This reform was generally in line with trends in many European countries since the 1980s. Its purpose was to strengthen the executive leadership of universities, to increase the efficiency of the public sector in general, and to enable the government to have a more active influence on the higher education system (Ferlie et al., 2008). The Dutch universities still retain this system of governance. It is generally regarded as having improved the effectiveness of university decision making and ability to respond to emerging problems. Examples include an increase in inter-organisational co-operation agreements and partnerships both at the international and national level, such as the strategic co-operation among the three technical universities in the Netherlands and a significant increase in the third flow of funds to university research (File and Stensaker, 2006), all outcomes greatly enhanced under the new governance system.

With regard to the governance of the UAS, they have in principle similar governance systems. They are autonomous and responsible only to government. Employers, SMEs and public-sector actors are involved in the process of developing curricula and similar matters, but have no decision-making power.

A major aspect of the performance agreements concerns raising the quality of teaching,[21] particularly in the UAS. The government's target to improve the qualifications of UAS teachers translates into more PhDs or master's degrees, with a goal of 80% by 2016 and 100% by 2020 (the share was 65% in 2009). Furthermore, the UAS are expected to implement accreditation systems similar to those that apply to the academic universities in a bid to raise the quality of teaching programmes. These measures seem appropriate considering the prominent role of the UAS in the Dutch tertiary education system. More broadly, the high dropout rates that characterise the university system as a whole will be partly tackled by introducing more selectivity in admissions, while maintaining the general principle that all students who are formally qualified should be able to obtain a university (research or applied science) study place. This should help to reduce dropout numbers, hopefully to a level closer to those of other leading economies, and create efficiency savings in the higher education system.

A further course of action to improve quality centres on adjusting the range of courses on offer at individual institutions. This calls for restructuring the range of programmes, reducing their number, and introducing profiling. Profiling is intended to lead to greater specialisation, as institutions are expected to focus on their strengths and to phase out weak programmes and disciplines. In the UAS, there will be a clearer distinction among programmes offered for target groups (e.g. associate degree programmes, tracks for pre-university students, professional master's degrees). In academic higher education, the bachelor's programmes will be broadened and profiling strengthened in the offer of master's degrees. Labour market relevance will become a more important issue in granting approval for new higher education programmes.

The reforms also include suggestions to promote lifelong learning. A comprehensive upgrading of adult skills relevant to innovation (including management, design, research and more sophisticated information technology skills) depends in part on participation in formal education in specialised, high-quality institutions. The Netherlands' national target is to have 20% of 25-64 year-olds enrolled in a study programme or training course by 2020. The current rate is close to 17% (Ministry of Education, Culture and Science, 2013a, p. 40); it is higher than the EU28 average but lower than in many advanced comparator countries. With their focus on professional education, the UAS have an important role to play in this respect; they are expected to expand their professional master's degree programmes and to make part-time programmes more flexible and better tailored to the needs of adult learners. At the same time, the government intends to liberalise student grants and to consider introducing loans for part-time students to encourage lifelong learning. These are all moves in the right direction, though improvements in lifelong learning also depend upon workplace arrangements and incentives to facilitate a return to formal education. The question, therefore, is not only about the provision of educational possibilities but also about attitudes in the population and the readiness of employers to grant study leaves for their employees.

Implementation of the performance agreements is backed up by changes in the university funding model. While the allocation of funds to universities had previously been exclusively formula-based (relying largely on indicators of student and diploma numbers, see Chapter 4), a new component in the funding model (with a scale of 7% of the education funding) has been introduced. 5% (the larger part of this 7%) is conditional on universities' strategic plan for "quality and profile". A university's strategic plan can also secure an additional 2% if it is deemed to be among the best. Though not overly generous, the new funds can provide some of the means for the practical measures needed for universities to improve their teaching activities.

There is a legal provision for conducting the performance agreements as an experiment. It is planned to make an interim evaluation of the universities' implementation of their performance targets on profiling in 2014 and to evaluate their performance on education quality and study success in 2016. The results of the first evaluation will affect funding allocations in 2015-16 for profiling (2%) and those of the second will influence funding in 2017-20. The system of performance agreements and performance-based funding will be evaluated in 2017 and its continuation decided on the basis of the results. If deemed successful and if extra resources are available, a larger portion of block grant allocations (perhaps as much as 20% according to the White Paper) is likely to be tied to multi-year performance targets.

An increasing number of university systems in OECD countries[22] use some sort of performance indicator or performance agreement procedure to allocate basic budgetary funds, although they differ in terms of the range of indicators, procedures used for budgeting, and external and internal steering of the universities.[23] In many countries, irrespective of whether they use performance agreements, resource allocation – usually for the block grant (Hicks, 2010) – relies on performance-based measures or evaluations. When developing performance-based indicators and performance agreements, there is the risk that they will try to promote too many policy goals and be too detailed and complicated. This does not appear to be the case of the Dutch system so far. However, it is important to monitor the impacts of performance agreements and evaluation systems closely and to assess their cost-effectiveness. The government's intention to make interim evaluations of the new arrangements is therefore sensible.

While it is too early to assess the impacts of these reforms, the introduction of individual university-based performance agreements strongly induces the universities to position their teaching programmes strategically. The first steps taken to encourage universities to think strategically, to analyse their strengths and weaknesses, and to adopt strategic targets seem to go in the right direction. The system for the review of strategic plans should also prevent inflated target selection. The emphasis on improving the quality of teaching is pertinent, considering the observed performance in terms of dropouts and success rates. Overall, the current university governance system enables universities to take strategic decisions and to respond to emerging challenges in their environment.[24]

Top sectors: Human capital agendas and the Technology Pact

Highly skilled human capital has been a key priority of the top sectors approach from the outset. The pool of specialised and skilled personnel in the Netherlands does not currently meet the demand of the business sector. For example, the Research Centre for Education and the Labour Market (ROA) estimates that an additional 30 000 technicians will be needed every year until 2016. Technical and skilled personnel shortages will become even more critical in the future, as employees retire.

The proportion of students in education programmes related to top sectors was estimated at about 14% in 2011 in the UAS and about 31% in the academic universities. The latter is broadly in keeping with the top sectors' share of total employment (between a quarter and a third). It has been estimated that the share of students in top-sector-related curricula increased by 16% in the UAS and by 14% in the academic universities over 2007-11, outstripping growth in non-top-sector fields (den Hertog et al., 2012b). There are some indications that skills shortages vary among the top sectors. A recent survey of relevant companies found that shortages were especially pronounced in high-technology systems and water, and to a lesser extent in life sciences, chemistry and energy (Ministry of Economic Affairs, 2013b). To address the existing and expected skills shortfalls, each top sector developed a Human Capital Agenda by 2012. The agendas include an analysis of demand for human capital in the sector, information on the education needed to meet this demand, and a description of how education institutions and the business sector can contribute jointly to developing curricula that will prepare students for the labour market. On the basis of these top sector agendas, a comprehensive agenda was drawn up that focused on the expected shortage of manpower with expertise in engineering and other technical fields.

Partly thanks to the human capital agendas, several Centres for Innovative Craftsmanship (which target secondary vocational education) and Centres of Expertise (set up by the UAS) were created. The centres are public-private partnerships that bring together researchers, students, teachers and the business sector to improve the quality of higher professional education and to become international training centres. Individual UAS can apply for a Centre of Expertise in a specific field in order to promote practice-oriented research and education in a focused way. Emphasis on education or research can vary, but the centres are expected to be aligned with the relevant top sector(s) or the education or health sectors. They collaborate with employers and aim to grow into sustainable public-private or public-public partnerships with relevant stakeholders. People already working in industry can come back to the centres for education, but the main target is regular students in the UAS. By 2013, 489 companies and 96 education institutions had been involved. The cumulative budget to 2015-16 will amount to EUR 113 million, of which EUR 51 million will have been provided by the private sector (Ministry of Economic Affairs, 2013a).

As a response to the comprehensive human capital agenda for manpower with a technical education, the government launched in 2013 the 2020 National Technology Pact, an initiative that brings together employer confederations, employees associations, national and regional authorities, the business sector, education and student associations. Co-operation between higher education institutions and the private sector is one of the main aspects of the Pact, which aims to increase the number of technically trained people in the Netherlands in order to meet the needs of the job market (Box 5.6).

Box 5.6. The Technology Pact

The Technology Pact has 23 action points and 22 national measures for all stages of the education cycle, from primary education to lifelong learning. Specific focus areas are science and technologies in primary education cycles, the development of an investment fund to promote co-operation between companies and schools/education institutions, and the increasing availability of grants for students in technical and technology-related education and training.

Examples of concrete measures and targets contained in the Technology Pact are: the introduction of science and technology classes in 7 000 primary schools by 2020; EUR 100 million to train secondary education teachers in technological fields; the creation of an online technology education portal; an increasing number of internships in technology-related firms; an increasing number of scholarships for top-sector-related higher education curricula; re-training programmes for the unemployed with a focus on technical and technological skills; and higher funding for students enrolled in technology programmes in schools offering senior vocational education. For 2014-15, the government allocated EUR 600 million for training in technical and engineering fields.

In addition to the national agenda, each region in the Netherlands has developed a Technology Pact that targets local labour markets. Examples are the Brainport Technology Pact, the Haaglanden Technology Pact and the Twente Technology Pact. The Technology Pact will be implemented in the regions, in co-ordination with the national level, through the National Technology Pact Co-ordination Group, composed of representatives of the five regions, the central government, employers, workers, the top sectors and education institutions.

Given the expected shortages in science and engineering (S&E) skills and the relatively small share of S&E graduates from Dutch universities, these top-sector measures are broadly welcome. However, attention should also be paid to the needs of other knowledge-intensive sectors, particularly in services. This will be important for sustaining continuing dynamism in non-technological innovation. It will be important to ensure alignment with the broader education policy agenda, i.e. the measures set out in the White Paper *Quality in Diversity* described above. A close monitoring of the effectiveness of co-ordination in the skills agendas and the various pacts should enable systematic learning from experience. A key policy task would be to draw broader lessons for national education policy.

5.6. Investing in public-sector research

The government plays a central role in investing in public-sector research. This includes support for fundamental research, principally through NWO and KNAW, but also support for applied research, mainly through the TO2 applied research institutes, such as TNO.

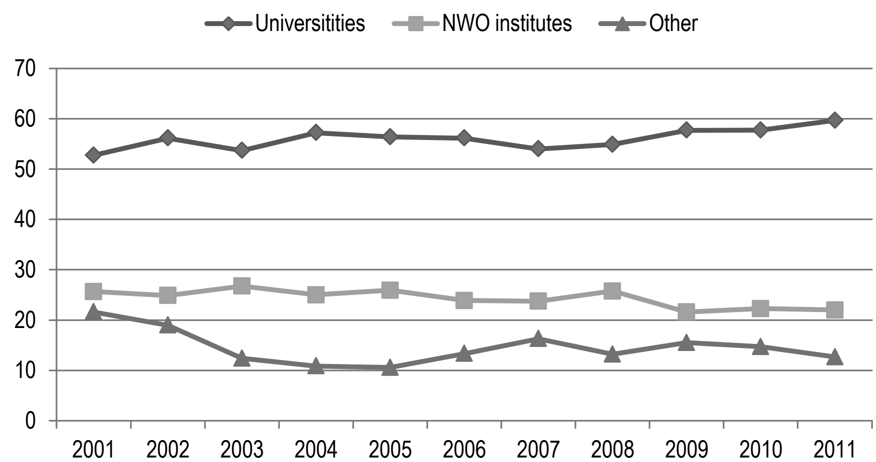
Funding fundamental research – the role of NWO

NWO is responsible for distributing a major part of the second flow of funds to Dutch universities and other knowledge institutes. It funds the best researchers and research groups on a competitive basis. They are selected by independent experts/scientists by means of peer review. NWO awards around 1 500 research grants a year. Dutch universities, knowledge institutions and NWO institutes are eligible for NWO grants. Almost 7 000 researchers (scientific and non-scientific) at Dutch universities, institutes, and research centres conduct research with financial support from NWO.

The revenue of NWO has risen sharply over the years, from EUR 433 million in 2001 to EUR 701 million in 2011, with a peak of EUR 727 million in 2010, for an average annual rise of 6.2% (Ministry of Education, Culture and Science, 2013a). The Ministry of Education, Culture and Science is the most important source of income: 84% of the total in 2012, given as a government grant and through a number of specific subsidies. In 2011 university research received 60% of NWO expenditure, and NWO's own institutes received 22% (Figure 5.9).

Figure 5.9. NWO expenditures by destination, 2001-11

Percentage of total



Source: Rathenau Institute, based on annual accounts NWO 2001-11.

NWO has several categories of funding instruments:

- *talent grant programmes* for individual researchers;
- *responsive-mode research* for curiosity-driven, non-programmed research;
- *theme-based research* for large-scale, long-term research programmes focused on a specific target or theme or research collaborations partly set up in close consultation with other partners;
- *large infrastructure* for the realisation and use of large-scale research and ICT infrastructure;
- *internationalisation* for research programmes focused on international collaboration and exchange, particularly in the context of EU funding;
- *knowledge utilisation* for knowledge dissemination and open access publication of research results.

The funding instruments cover the entire spectrum of fundamental and applied research. Knowledge utilisation (societal and scientific applicability of the results) is increasingly a criterion in the assessment of funding instruments (see below). The frequency of funding rounds varies according to the instrument, from one a year, or several rounds a year, to submission on a continuous basis. Funding instruments can be specific to an NWO division or a group of NWO divisions. Other instruments concern the NWO as a whole. Table 5.10 shows that the talent programme was most popular in 2011, followed by the open responsive-mode (curiosity-driven) research programmes. Both types of funding instrument are over-subscribed, with success rates of around 20% in 2011, slightly on the low side by international standards. In fact, success rates are reported to have fallen further in 2012 to around 17% (NWO, 2013). This suggests strong demand for more open types of fundamental research funding. By comparison, success rates in the other programmes are considerably higher, e.g. in the theme-based programmes, the success rate was 35% in 2011.

Table 5.10. Number of NWO applications by type of programme and success rates, 2011

Type of programme	No. of applications	Success rates (%)
Talent (individual grants)	2 073	19
Responsive-mode research	1 294	21
Theme-based research	421	35
Large infrastructure	238	69
Internationalisation	221	50
Knowledge utilisation programmes	84	33
Total	**4 331**	**26**

Source: Ministry of Education, Culture and Science (2013a).

A large part of the results of research funded by NWO is published in peer-reviewed scientific publications (Table 5.11). Their number has grown considerably in recent years, matched by a sharp decline in non-peer-reviewed journal articles. This no doubt reflects strong pressures on researchers and research-performing organisations to demonstrate research excellence, with peer-reviewed journals viewed as the gold standard. The category of "other professional products and publications" is also large and has grown rapidly. This category comprises publications for professionals, the general public, as well as the members of the editorial staff of a scientific journal, inaugural speeches, designs and prototypes and media events (Ministry of Education, Culture and Science, 2013a). This growth probably reflects the increasing emphasis on knowledge utilisation activities in all NWO-funded projects, or at least the increasing demand for researchers to account for them in their reporting.

Table 5.11. Academic output of research funded by NWO

	2007	2008	2009	2010	2011
Publications in peer-reviewed journals	7 576	10 674	9 525	8 943	9 528
Publications in other academic journals	2,655	1,766	1 228	714	488
Contributions to books	980	1,218	1 334	1 237	1 017
Studies	302	336	385	327	293
Doctoral theses	609	794	832	774	698
Other professional products and publications	4 643	5 476	5 906	6 949	6 796
Patents	52	57	53	42	56

Source: Ministry of Education, Culture and Science (2013a).

The sections that follow briefly describe the talent, thematic and large infrastructures programmes before turning to an examination of the impacts of the top sectors approach on NWO funding.

Talent grant programmes

A large part of NWO's funding is channelled through talent programmes that target individual researchers. In 2000, NWO launched the Innovational Research Incentives Scheme aimed at making a contribution to modernising research at Dutch universities and improving the career prospects for young researchers. This individual subsidy system focuses on three target groups:

- *Veni grants*: for (young) talented researchers who have recently taken their PhD, to allow them to continue to develop their ideas; up to a maximum of EUR 250 000.
- *Vidi grants*: for researchers who have already performed research at the postdoc level for a number of years and who want to develop an innovative line of research and appoint one or more researchers; up to a maximum of EUR 800 000.
- *Vici grants*: for senior researchers to form their own research group, often in preparation for a permanent professorship; up to a maximum of EUR 1.5 million.

From 2000 through 2012, 2 635 grants were awarded for an average of some 240 grants a year, making this by far the largest NWO scheme for individual researchers. Of these grants, 2 353 were awarded to universities. The universities of Leiden, Utrecht and Amsterdam top the list (Ministry of Education, Culture and Science, 2013a). The aim is to promote innovation in academic research, as well as to encourage talented researchers to enter, and remain committed to, the scientific profession. The scheme seeks to encourage individual researchers and gives talented, creative researchers the opportunity to conduct their research programmes independently. Researchers who are among the best 10-20% of their age group may apply for these grants. Other prominent schemes for individuals include PhD scholarships, the Spinoza Prize (EUR 10 million a year), and mobility programmes for young researchers (e.g. Rubicon, with an annual budget of EUR 7 million).

Although the share of female scientists working in the Netherlands has risen significantly in recent years, Chapter 3 has shown that strong deficits remain, particularly at higher steps on the career ladder, where Dutch women are markedly under-represented. It is important to tackle this issue as a matter of priority, not only on the grounds of equity but also in order to utilise Dutch talent fully. Bottlenecks may occur at various stages of scientific careers, from the initial choice to embark on a science- or innovation-related education, to educational development, recruitment and promotion. NWO has a few discipline-specific schemes to support early-career developments for female scientists, notably Athena in chemistry and FOm/f in physics, which are targeted at postdocs. The more generic Aspasia grant scheme is targeted at the mid-career stage. Both Aspasia and Athena are aligned with the Innovational Research Incentives Scheme (see Box 5.7).

Box 5.7. NWO programmes supporting women in science

Aspasia

Aspasia grants ensure that more female assistant professors progress to the level of associate or full professor. The scheme is linked to the NWO talent grants: Vidi (for experienced postdoctoral researchers) and Vici (for senior researchers). Eligible candidates are female applicants who have received a Vidi or Vici grant and female applicants who did not obtain a Vidi or Vici grant, but were judged very good or excellent after the interview selection. University executive boards who promote these candidates to an associate or full professorship within a year of the granting of the Vidi or Vici are eligible for a grant under certain conditions. In both cases, NWO contacts candidates eligible for Aspasia grants. For applicants who receive funding in the Vidi and Vici competition the grant is EUR 100 000. For other applicants the grant is EUR 200 000. The programme's 2011 budget amounted to EUR 4 million.

Athena

In the natural and technical sciences, women are underrepresented at the assistant, associate and full professor levels. The Athena grant is intended for female researchers who have received a Veni grant from NWO Chemical Sciences. It is for researchers who have recently obtained a PhD and encourages the appointment of female researchers in chemistry to tenured assistant professorships or to a comparable position at a research institute. The grant is EUR 100 000 for a maximum of three years and can be used for salaries of personnel to be appointed (PhDs, post-docs, technicians), costs of purchasing material, equipment or databases, and costs for travel and visits to conferences or research institutes. NWO Chemical Sciences contacts the Veni awardees and the university executive board or the directorate of the research institute after the Veni grant has been allocated. If the laureate would like to be appointed as an assistant professor and if the university or institute board can make the appointment during the duration of the Veni project, the Veni laureate is eligible for the Athena grant.

FOm/f grants

FOM initiated the FOm/f incentives programme to retain female scientists in the Dutch physics community. Individual positions for postdocs are intended for women who wish to develop a long-term career in Dutch physics. FOM funds a postdoc position for a maximum of three years spread over a period of at most five years. The condition is that the candidate organises a period of one to two years at a foreign institute (not paid for by FOM) in conjunction with her domestic stay. The candidate is free to plan the period abroad either before or after the period funded by FOM. Women who have just gained their doctorates or who already have a postdoctoral position abroad are eligible to apply. The budget for the individual postdoc position is a personal budget for a maximum of three years.

Source: NWO website, www.nwo.nl.

Theme-based research

NWO also funds research through thematic calls. The choice of thematic areas changes from one strategic planning cycle to another, though the names of the themes suggests a certain degree of continuity (Table 4.13). The latest themes (for 2011-14) were selected in consultation with the national government, TNO and European priorities. Initially, NWO selected six themes directly related to social and grand challenges: healthy living, water and climate, cultural and societal dynamics, sustainable energy, connecting sustainable cities, solutions for scarcity of materials. With the launch of the government's top sectors approach, the list of themes was revised to align better with the sectors covered (Table 5.12 shows the nine adjusted themes for 2011-14). This means that this funding is now almost entirely shaped by the roadmaps of the top sectors (see below). Thematic calls aim to bring researchers and industry together to conduct innovative scientific research. Particular attention is paid to research carried out in partnership with industry.

Table 5.12. NWO thematic area themes over three programming cycles

2002-05	2007-10	2011-14
Cultural heritage Ethical and social aspects of research and innovation Shifts in governance Cognition and behaviour Fundamentals of life processes System Earth Digitalisation and information technology Nanosciences Emerging technologies	Conflict and security Cultural dynamics Sustainable earth Dynamics of complex systems Basic energy research Brain and cognition Knowledge base for ICT applications Dynamics of life courses Responsible innovation Use of nanosciences and nanotechnology New instruments for health care Research & innovation in smart creative contexts Systems biology	Agro, food and horticulture Creative industry Sustainable energy High-technology systems and materials Healthy living Materials: solutions for scarcity Cultural and societal dynamics Connecting sustainable cities Water and climate

Source: NWO website, www.nwo.nl.

Large infrastructure investments

NWO provides the scientific community with access to large-scale research facilities, via the nine NWO institutes and through participation in international research facilities. The Dutch government acknowledges the importance of large-scale research facilities as essential to excellence in science, technology and innovation, and in particular for attracting and retaining excellent researchers and scientists and promoting interdisciplinary research. Inspired by European roadmaps for research infrastructure (see Box 5.8), a first national roadmap for large-scale research facilities was developed in 2007, to be implemented over 2008-12. It covered 26 research facilities and allocated a budget of EUR 63 million through NWO.

Box 5.8. ESFRI roadmaps

National research infrastructure roadmaps in the Netherlands have been developed in response to the European roadmap for research infrastructure, launched by the European Strategy Forum on Research Infrastructure (ESFRI). ESFRI was established in 2002 to achieve a coherent strategy at European level for the development and use of large-scale research infrastructure. In 2004, ESFRI developed the first EU roadmap; it was updated in 2008 and 2010. One of the achievements of these roadmaps has been the development of an appropriate legal framework for the development of joint research infrastructure in European member countries. The Netherlands promptly adopted the new legal framework and applied it in a number of cases. As in the case of other EU instruments, the Netherlands participates significantly in ESFRI projects. Three European facilities are hosted in the Netherlands.

Given the risk of obsolescence of research facilities and the emergence of new large-scale research projects, the Ministry of Education, Culture and Science updated this first strategy with a new one in 2013 (Ministry of Education, Culture and Science, 2013b). This new roadmap is largely the work of an independent advisory committee set up by NWO. It has a budget of EUR 80 million and an additional EUR 15 million for e-infrastructure projects. In addition, NWO has committed to allocating in 2014 an additional EUR 75 million to fund some of the roadmap projects. The updated national roadmap focuses on 28 large-scale research facilities, five of which were selected for funding: two facilities in the biological and medical sciences (for a total of EUR 32 million), two facilities in physics, astronomy, astrophysics and mathematics (for a total of EUR 29 million) and one in chemistry and material sciences (EUR 18.5 million). Three other projects were selected for "seed capital", with a much smaller amount of funding: one in the biological and medical sciences (EUR 1 million), one in the social sciences (EUR 0.5 million) and one in the humanities and arts (EUR 1 million). The selection criteria for funding the facilities took various elements into account: likelihood of scientific breakthroughs and attraction of talent, social and commercial relevance (in particular the connections between the facilities and the top sectors approach and social challenges at both national and European level), financial costs, critical mass, willingness to collaborate with multiple research groups, and degree of connection to current social trends.

In 2013, at the request of the Ministry of Education, Culture and Science, AWT issued an advisory document on the national roadmap for large-scale research facilities (AWT, 2013b). The document discusses the alignment of the national Dutch roadmap with the European strategic agenda, the areas of specialisation of the universities and PRIs, and the top sectors approach. In particular, AWT suggests the need for universities, research institutes and top sectors to specify how they plan to use large-scale research facilities. According to AWT, the national roadmap should focus on research facilities that are important not only for actors in science and education but also for their broader social and economic impacts. To ensure the development of a strategic approach, AWT recommends the creation of an independent Committee of Large-Scale Research Facilities that will manage and co-ordinate investments.25 AWT also notes the need for an inventory of existing large-scale research facilities and their regular monitoring and evaluation. These sensible proposals should be given consideration by the government.

Research valorisation[26] and the effect of the top sectors approach on NWO funding

Among the multiple requirements addressed to the universities are the strengthening of the links with the industrial environment and making alliances with other universities or knowledge institutions. Research universities, many of which are world-class, and the universities of applied sciences, which are only now developing their research capabilities, clearly have different, but important roles in this situation. The universities of applied science can link with and help improve the capabilities of regional industrial actors, while the task of the world-class research universities is to pursue world-class science.

The Netherlands has appropriate framework institutions for the utilisation and commercialisation of university research findings. The country early on reformed its legislation on patenting: the *Patent Act* of 1995 stated that if the invention is made by an employee of a university or research institute, the employer is entitled to the patent, though partners may agree not to apply the statute (Leisyte, 2011). After the reform, universities have sought to retain and exploit their intellectual property rights (IPR). The government also has a relatively long history (going back to the 1980s) of operating several direct funding schemes to promote technology transfer, spin-off firms and science-industry links both in sector-specific and general schemes (Zomer et al., 2010). The external evaluations of the universities at six-year intervals also pay attention to societal relevance of research (see below).

While the Netherlands offers many examples of good valorisation practices (see Box 5.9 for an example in Utrecht), the Dutch government considers that more should be done to promote research valorisation. In 2009, it prepared a national Valorisation Agenda (NOI, 2009), because valorisation performance in knowledge institutes, companies and civil society organisations seemed less than optimal. This implies that technology-transfer opportunities are not fully exploited and that economic and social returns to public R&D are insufficient. The Valorisation Agenda proposed a meeting- and market-place for research, education, business and civil actors in order to promote open collaboration and the exchange of people and ideas and to create opportunities to exploit knowledge and creativity more generally. It set three specific tasks: to develop jointly a term action plan by the government and various stakeholders; to define a consistent set of measures and streamlined policy instruments; and to create a cultural shift in favour of valorisation. Following the agenda, NL Agency (now RVO) launched the Valorisation Programme in 2011 to strengthen and professionalise the valorisation infrastructure around several knowledge institutes. With a budget of EUR 63 million, 12 consortia have been supported for six years to strengthen their entrepreneurship education and knowledge transfer activities. The programme is now closed to new applications.

Box 5.9. Utrecht Valorisation Centre (UtrechtVC)

UtrechtVC is a valorisation and knowledge transfer support network serving Utrecht University, University Medical Centre Utrecht, and the HU University of Applied Sciences. It was set up in 2011 with the support of the Ministry of Education, Culture and Science and the Ministry of Economic Affairs. UtrechtVC serves as a primary contact point for academics and staff in all matters relating to knowledge valorisation initiatives, questions and networking. The network includes valorisation officers in the institutes and Utrecht Holdings for support on intellectual property and start-up. Its core activities are: to help researchers to protect and apply their knowledge and inventions; to transmit research questions from SMEs and civil society organisations to researchers and students; to help starting entrepreneurs establish and grow their business (with financial options co-ordinated with Rabobank); and to shape entrepreneurship and innovation education, for example, through training university staff and researchers.

Source: Utrecht Valorisation Centre website, http://utrechtvc.nl.

The agenda was followed by proposals in the 2011 *Quality in Diversity* White Paper for improving research valorisation in universities. It defined a number of tasks: making valorisation a task for universities and PRIs, for example, through the professionalisation of valorisation staff; enhancing public-private collaboration in research, for example, through the top sectors; including valorisation as a criterion in the assessment of research proposals;[27] extending provision for education in entrepreneurship; increasing the STW budget to allow for the award of more STW valorisation grants; and optimising open access to scientific information.

The tasks defined in the Valorisation Agenda and the White Paper are laudable, but it is important to ensure that the valorisation strategies of funding agencies and research performers are realistic regarding the demand for public research from the private sector. There is always a danger of placing too much emphasis on knowledge supply-side measures when there are persistent bottlenecks in the capacities and behaviour of parts of the business sector. There is also a strong need to broaden the concept of valorisation and improve its measurement. Box 5.10 briefly describes some pioneering work recently carried out by the Rathenau Institute and STW to develop indicators of valorisation activities, broadly defined. This work may be useful for evaluating the top sectors approach, given its strong focus on public-private partnerships, and should be taken into account accordingly.

Box 5.10. Indicators for valorisation

In 2010, STW, the Rathenau Institute and Technopolis were commissioned to develop a list of generic indicators to measure valorisation performance. The indicators had to be applicable in a wide variety of settings, on several levels and for a variety of evaluation goals. The authors soon discovered that there was no ready-made set of indicators that matched the broad definition of valorisation. They were also critical of the use of "number of patents" as an indicator of valorisation, arguing that the broader societal and economic use of scientific knowledge needs to be accounted for. Furthermore, greater attention needs to be paid to the valorisation "process" (viewed as a process of interaction during *all* stages of research rather than just the transfer of knowledge at the end of a research project) when trying to measure valorisation performance, rather than simply counting "outputs". Combining quantitative and qualitative indicators, the study proposed a comprehensive four-dimensional framework that could be applied in various situations, including research universities, the UAS, and a research council's thematic programme.

Since its publication in 2011, the framework has been used in a variety of ways, including by NWO and RVO, and has been discussed in parliament. It is credited with having moved valorisation measurement discussions away from focusing only on quantitative indicators of researcher and research organisation performance to a broader, more process-oriented approach that includes other actors as well (van Drooge and Vandeberg, 2013). Indeed, inspired by this study and by an EC (2011) report on a composite indicator for knowledge transfer, the VSNU and the Vereniging Hogescholen have agreed with the government to develop such a broader set of valorisation indicators based on their experience of types of valorisation in different areas of research. A well-balanced and tested set of indicators is expected to be ready by 2016.

Source: Rathenau Institute and STW (2011), *Valuable – Indicators of Valorisation*, Rathenau Institute, The Hague; van Drooge and Vandeberg (2013).

NWO and the top sectors

A central objective of the top sectors approach is greater collaboration between universities, PRIs and industry with a view to the utilisation of scientific research for the benefit of the national economy. The approach is built on the assumption that the current – or previous – mechanisms for industry-university interaction and collaboration are not effective enough and need strengthening. Research funding gives government a significant lever for promoting more interaction and collaboration between public-sector research and firms. As the largest source of indirect competitive research funding in the Netherlands, NWO is expected to play its part in promoting this interaction through the top sectors. In 2012 and 2013, NWO invested EUR 225 million a year in top-sector-related research. Its investment is set to increase to EUR 275 million a year from 2015 (out of a total NWO budget of EUR 625 million a year). To cover some of the top-sector investment costs, the government has increased the NWO budget: the Ministry of Education, Culture and Science will increase the NWO budget by EUR 25 million in 2014, EUR 75 million from 2015 to 2017 and EUR 100 million from 2018 onwards. Over 2014-16, the Ministry of Economic Affairs will make an extra one-off investment of EUR 50 million for public-private partnerships in the top sectors.

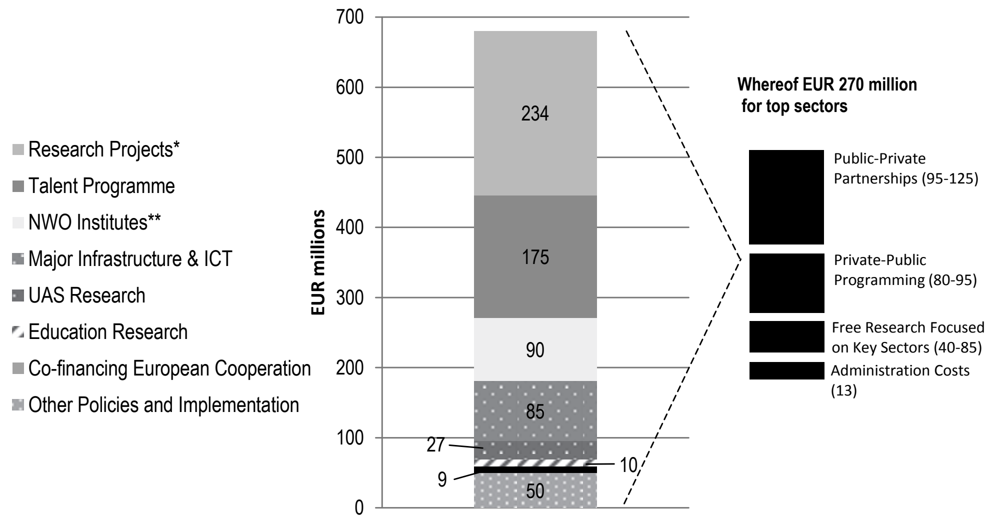
As shown in Figure 5.10, top-sector-related investment is distributed across NWO's entire budget and is an integral part of NWO policy. To safeguard the quality of the scientific research it funds in the top sectors, NWO relies on open competition with standard quality criteria and independent experts, i.e. peer review. Furthermore, it provides tailored opportunities in the top sectors, from large-scale programmes to smaller projects that involve a single company. To increase the transparency of NWO's contribution to the top sectors, funding is organised according to three pillars:

(i) *Public-private partnerships*: This is the only pillar for which companies are expected to contribute to research costs. The main research system stakeholders, representing funding agencies, research performers and industry, agreed in 2013 on a set of "rules of the game" to govern collaboration by researchers and industry in the top sectors. The rules introduce three variants of public-private partnerships involving NWO (Table 5.13), according to the intensity of the collaboration and the amount of co-funding industry needs to provide. Variants 2 and 3, involving joint programming with top consortia for knowledge and innovation (TKIs) and/or individual firms, account for the largest slice of funding, in the range of EUR 80-105 million for 2015 (Table 5.14). Co-funding by companies in these programmes ranges between 10% and 50% and can, in variant 2 programmes, be a mix of in-kind and in-cash contributions.

(ii) *Private-public research programming*: This pillar is characterised by joint programming without a compulsory contribution by companies. It has five components: thematic programmes, the (in-kind) contributions of NWO institutes, large research infrastructure, practice-oriented research in the UAS, and European programmes. The budget in 2015 is expected to be in the range of EUR 80-95 million, with about half accounted for by investments in large research infrastructure (Table 5.14).

(iii) *Non-programmed research targeted at the top sectors*: This pillar consists of research grants exclusively for the top sectors with no private co-funding requirements. They are delivered via broad calls for non-programmed, curiosity-driven research, including through the talent grant programmes. The budget in 2015 is expected to be in the range of EUR 40-85 million (see Table 5.14).

Figure 5.10. Projection to 2015 of NWO budget by type of programme, including top sectors



Note: *Includes open curiosity-driven research and thematic programmes (including public-private programmes). **Includes basic budgets and support to top sectors.

Source: NWO Budget Factsheet, October 2013, available from NWO website, www.nwo.nl.

Table 5.13. Three variants of public-private partnerships (PPPs) involving NWO

Variant	Approach	Role of partners	Partners' contribution	NWO budget (2015) million EUR
Variant 1: Scientists take the initiative for a joint research proposal with opportunities for companies/organisations	Scientists submit a research proposal with the support of partners in broad calls/tenders (all top sectors)	Follow the research and actively participate in it when tangible results are on the horizon	Make a limited contribution at project level: 1-20%, mostly in-kind	15-20
Variant 2: Scientists and partners jointly formulate a knowledge question related to a top sector or several roadmaps	Together with NWO, scientists and partners draw up programmes with a thematic focus (top sector or roadmap)	Actively participate in the research	Make a considerable contribution at project level: 10-40%, mix of in-cash and in-kind contributions	80-105
Variant 3: A company or consortium of companies has a specific knowledge question and initiates research together with scientists	Company or consortium takes the initiative for a programme (related to a roadmap) and together with NWO invests in research	Enter into a long-term partnership with researchers; are highly involved in the research throughout the duration of the programme; and are closely involved in formulating the research questions and monitoring the projects	Make a substantial contribution of 30-50% or more at the programme level which, in principle, is entirely in cash	

Source: Based on information obtained from the NWO website (www.nwo.nl).

Table 5.14. Projected NWO annual contributions to the top sectors, by pillar (from 2015)

EUR millions

Pillars of NWO's contribution to the top sectors	NWO projected budget for 2015 (million EUR)
(i) Public-private partnerships	95-125
- Variant 1 (project-based)	*15-20*
- Variants 2 and 3 (programmatic)	*80-105*
(ii) Private-public programming	80-95
- Theme-based programmes	*10*
- Contributions by NWO Institutes	*10-15*
- UAS practice-oriented research	*10*
- Large research infrastructure	*40-50*
- European matching funds	*10*
(iii) Talent and responsive-mode research programmes	40-85
NWO overhead	13
Total	**275**

Source: NWO (2013), *NWO bijdrage aan de topsectoren 2014-2015*, in Dutch.

Joint programming in the top sectors seems a promising way to encourage complementarity of public and business innovation investments. The wish to increase the applicability of public research is laudable. However, the present requirements for business-sector commitments appear to be light and to take a wide range of forms: business co-funding, contributions in-kind, declarations of interest. This may be at odds with the business sector's now central position in setting R&D and innovation agendas for public R&D. This level of commitment may be necessary temporarily, given that relationships and arrangements for public-private partnerships will need a few years to develop. But the rules should be kept under scrutiny, with a view to increasing commitments from business, while recognising the likely continuing importance of in-kind contributions for SMEs. It will also be important to ensure that complementarity effects dominate possible crowding out.

There are other possible risks and trade-offs that policy makers need to be cognisant of, particularly with respect to the leading position of Dutch universities and knowledge institutes, which already make crucial contributions to the Dutch economy.[28] Further increasing university alignment with the needs of industry may be fruitful but also harbours risks (see Box 5.11 for a recent example of how things can go wrong). Insofar as the apparent shortcomings in collaboration are due to unambitious forms of innovation in parts of the Dutch business sector, alignment risks diverting the attention of top research universities away from the frontier, which could jeopardise their strong positions and capabilities.[29] Carefully designed policies can strive for complementarity by using universities to raise the scope of business innovation and by ensuring that greater alignment does not lead to loss of valuable diversity in public research. Nevertheless, the policy drive for valorisation in public research may quickly approach limits unless accompanied by policies to institute lasting changes in the capacities and behaviour of parts of the business sector, too (see Section 5.4). In a recent communication, AWT (2013a) highlighted the problem of equating the "demand side" with the needs of industry.[30]

Box 5.11. Lessons from Finland: Evaluation of the Finnish SHOKs scheme

In the Finnish scheme, strategic centres for science, technology and innovation (SHOKs), existing large firms, as in the Netherlands, lead the formulation of strategic research agendas. The evaluation of this scheme in 2013 indicated that this had led to fairly short-term and unambitious research projects that did not meet the original objectives. The Finnish SHOKs are built, as in the Netherlands, around strong industrial sectors. The tendency for a short-term focus in spite of the original ambitious goals and too little influence by academic researchers on the agenda, a lack of quality control and expert evaluation of the proposals were listed among the factors that have made the Finnish scheme less attractive for academic researchers. The funding arrangements have been different from those normally deployed, and Tekes has been the major public funder of the scheme. Furthermore, the rule that IPR is to be shared among participants has caused problems for commercialisation of knowledge. This shows that programme design may create conditions that thwart the goals to be achieved. The Finns are attempting to make changes in the programme, but this is more difficult after the fact than at the outset.

Source: Lahteenmaki-Smith et al. (2013), "Licence to SHOK? External Evaluation of the Strategic Centres for Science, Technology and Innovation", Finnish Ministry of Economy and Employment, Helsinki, available at: www.tem.fi/julkaisut?C=98033&xmid=4981.

A further risk associated with the top sectors, often expressed in the Netherlands, concerns the present "bandwidth" of NWO funding. Since top-sector-related research is largely funded by shifting existing expenditures, it has a great impact on the orientation of research. The share of NWO funds used to support top-sector-related research is relatively high, at around 44% from 2015 onwards. This limits the money available for new topics and important research areas that are not directly relevant to the top sectors. The government has asked KNAW to report on the effects of the top-sector policy on budgetary support for free and fundamental research. The findings are expected to be published later in 2014. In an interim assessment (KNAW, 2013), KNAW complains that the "budgetary scope for free and unbound fundamental research outside the top sectors is roughly half what it once was . . . [Yet], it is impossible to predict in advance which discipline will suddenly become important for theoretical and practical innovation. That is why it is necessary to continue investing in science across the entire board." Coming from a different direction, the high-technology systems and materials (HTSM) top team has complained in its most recent innovation contract (HTSM Top Team, 2013) that the "present bandwidth of public funding for NWO and the applied research institutes leaves insufficient room for structural new research". The HTSM top team goes on to call for higher investments in science and technology *outside* of its own sector and outside of public-private partnerships as "a necessity for maintaining a competitive knowledge infrastructure in the Netherlands". Finally, it should be noted that the selection of the top sectors and the ensuing agendas reflect the concerns of present-day industries and may exclude novel research directions. Thus, there may be insufficient space for new openings and unexpected, risky topics.

Research profiling and assessment

In addition to research funding, other mechanisms shape the research activities of the academic universities. These include research profiling, introduced in the White Paper *Quality in Diversity* on higher education, research and science (see Section 5.5), and long-standing research assessment arrangements.

Research profiling

The government's 2011 White Paper makes proposals regarding universities' research activities, particularly as regards profiling to support the top sectors approach and the valorisation of research. The principle of profiling and specialisation in teaching and research implies that universities should focus more on their strengths and phase out weak programmes and research disciplines. The focus areas will also have to be linked with the grand challenges in the EU Horizon2020 programme. These policy changes emphasise collaboration among research universities, but also with research institutes and companies. Every university is expected to be among the world's leaders in some fields. NWO and KNAW institutions will also be involved in this process.

Encouraging greater functional specialisation could help reconcile the need for increasing valorisation with maintaining the leading position of Dutch science. The on-going profiling exercise for individual universities can be fruitful in this respect, potentially allowing them to specialise in R&D and innovation niches that collectively serve a wide spectrum of industry stakeholders. This is, however, not guaranteed. There is also the risk that the drive towards greater specialisation through profiling will mean that some weaker or otherwise unattractive disciplines or research areas may disappear from the Dutch research landscape altogether. This could jeopardise the research system's coherence, lead to partial dependence on foreign scientific advice, and present an obstacle to the viability of some interdisciplinary research. A recent report (KNAW, 2013) advises that while the impact of profiling cannot be foretold, to reduce the risk of "blank spots", profiling should be accompanied by a "crystal-clear vision" of the importance of the various disciplines and sub-disciplines for science in the Netherlands. Such a vision, the report argues, should provide the basis for agreements about a division of tasks and subsequent concentration.

Research assessment

The Dutch universities have since the 1980s been exposed to evaluation of their research activities by groups of external experts, and since the early 1990s this has taken place at regular six-year intervals. There is an internal evaluation every third year. External evaluation of research units uses a standard evaluation protocol (SEP) developed by the universities association VSNU, NWO and KNAW, which is revised for each six-year cycle. Since the early 2000s, it has also been applied to the research institutes of the NWO and KNAW. Evaluations take place at two levels: the individual research unit and the co-ordinating research institute as a whole. The government does not use the results of the evaluation for funding allocation decisions, as in some other OECD countries. Instead, university administrators mainly use the results for planning. Research units themselves also use them to enhance their reputations, although grade inflation now means that virtually all research units are rated good or excellent. Box 5.12 provides a short description of the SEP evaluation process.

Box 5.12. The SEP "in a nutshell"

All research conducted at Dutch universities, university medical centres, and NWO and KNAW institutes is assessed regularly in accordance with the SEP. External assessment committees conduct these assessments for each unit or institute once every six years (on a rolling schedule). The institution decides how the unit will follow up on the external assessment committee's recommendations. The external assessment concerns research that the research unit has conducted in the previous six years and the research strategy that the unit intends to pursue going forward.

The boards of the universities, NWO and the KNAW are responsible, within their own realm, for seeing that the assessments are carried out. They decide when an assessment is to take place and which research units will be assessed. The boards draw up a schedule of assessments and inform the research units well in advance. They may also decide jointly to undertake national assessments of research fields. The board of the institution must specify the terms of reference for each assessment. It determines the aggregate level of assessment and selects an appropriate benchmark, in consultation with the research unit. The board appoints an assessment committee. The committee should be impartial and international. The committee must be capable, as a body, of passing a judgement regarding all assessment criteria.

The research unit subject to assessment provides information on the research that it has conducted and its strategy going forward. It does this by carrying out a self-assessment and by providing additional documents. The assessment committee reaches a judgement regarding the research based on the self-assessment, the additional documents, and interviews with representatives of the research unit. These interviews take place during a site visit. The committee takes into account international trends and developments in science and society as it forms its judgement. In judging the quality and relevance of the research, the committee bears in mind the targets that the unit has set for itself.

The assessment committee bases its judgement on three assessment criteria: research quality, relevance to society, and "viability" (the extent to which the unit is equipped for the future). In its report, the assessment committee offers that judgment both in text (qualitative) and in categories (quantitative). The four possible categories are "excellent", "very good", "good" and "unsatisfactory". The committee also makes recommendations for the future. The assessment committee considers two further aspects: PhD programmes (including those at the national research schools) and research integrity. Here, the committee limits itself to a qualitative assessment. Finally, the assessment committee passes a judgement on the research unit as a whole in qualitative terms.

The board of the institution receives the assessment report and acquaints itself with the research unit's comments. It then determines its own position on the assessment outcomes. In its position document, it states the consequences it attaches to the assessment. The assessment report and the board's position document are then published.

Source: VSNU, KNAW, NWO (2014), "Standard Evaluation Protocol 2015-2021. Protocol for Research Assessments in the Netherlands", https://www.knaw.nl/en/news/publications/standard-evaluation-protocol-2015-2013-2021.

In Australia, Denmark, Norway, New Zealand, Finland, and the United Kingdom, performance agreements include elements of both educational and research achievements (Benneworth et al, 2011; Hicks, 2010). In Australia and the United Kingdom, performance-based allocation of funds to universities has been in place for two decades or more. It has been noted that these systems have probably influenced publication patterns of scientists in ways that are not fully intended (such as targeting lower- or higher-quality journals depending on the relative importance of quantity or quality in the assessments), but have also brought about unintended human resource problems concerning work motivation and academic transfer markets for hiring staff just before the assessments (Butler, 2010). Recent changes in the SEP evaluation framework attempt to address some of the perverse incentives introduced by a reliance on scientific publication indicators. The number of evaluation criteria has been reduced to three – scientific quality, societal relevance and viability; the productivity criterion was dropped, thus giving a clear signal that quantity is no substitute for research quality.

Specific support to applied R&D in the UAS

The UAS still have rather limited resources for research. The government has taken specific initiatives to promote their research capabilities and to help strengthen their knowledge transfer function, especially towards regional SMEs and public sector organisations (e.g. in the areas of health or education). Among the policy interventions with these objectives in mind are the appointment of lectors (see Section 4.2), the Centres of Expertise programme (see Section 5.5), and the RAAK (Regional Attention and Action for Knowledge circulation) programme.

RAAK aims to stimulate innovation in smaller firms, focusing on somewhat more incremental types of innovation. Programme funds can be awarded to regional innovation programmes for the exchange of knowledge, which are executed by a consortium of one or more education institutions and one or more enterprises. They can also involve research institutes, and TNO is the most frequent scientific collaboration partner in RAAK projects, followed by the University of Utrecht and the Delft University of Technology. The initiative for the development of the regional consortia comes from the regional SMEs.

RAAK began as a two-year programme in 2004. It has been subsequently extended to a four-year programme and is divided into three separate sub-programmes: RAAK SME, RAAK public sector (involving organisations such as hospitals), and RAAK PRO, the last with larger project budgets. Its funding has grown rapidly from EUR 6 million in 2004 to EUR 22.7 million in 2012. There was a small decrease in 2013 (EUR 20 million), but funding is expected to grow again from 2014 onwards. Up until the end of 2013, the RAAK programme was managed by the Innovation Alliance Foundation (SIA), with funding from the Ministry of Education, Culture and Science. As of January 2014 the scheme is part of NWO and is managed by a new temporary taskforce, the National Steering Committee for Practice Oriented Research. Becoming part of NWO is intended to support further improvements in the quality of practice-oriented research and to facilitate the integration of the UAS into the national research system. In addition to supporting the development of the research function of the UAS, the taskforce intends to initiate activities that strengthen the articulation of research with education and professional practice, thus leading to improvements in the traditional functions of the UAS.

The RAAK programme entails projects in collaboration with SMEs and often with other research partners (TNO, universities). This provides the UAS with valuable learning experience and facilitates knowledge spillovers among all parties concerned. A welcome by-product is that the UAS collaborate extensively with research universities and PRIs (Sealy *et al.*, 2013), an important step in the development of their research capabilities and conducive to coherence in the national research system. Overall, the role of the UAS in business innovation is not very extensive and there is much room for development. The RAAK programme does not exclusively fund research; it also enhances innovation in SMEs, via research but also through the application of available knowledge. The drive to increase the research and innovation capacities of UAS and the development of centres of expertise appears to be consistent with catering to the innovation needs of firms that may not be fully served by the more established research universities. Even so, it will take time for the research function of the UAS to develop their full potential.

Support to the applied research institutes

Responsibility for the TO2 applied research institutes passed to the Ministry of Economic Affairs during the Rutte I government; it was previously the responsibility of the Ministry of Education, Culture and Science. The Ministry of Economic Affairs is responsible for the framework in which the institutes operate and steers them with a view to certain preconditions (e.g. the top sectors approach) and the effectiveness and efficiency of the system as a whole. The government's policy towards the TO2 institutes was recently rearticulated in a position paper, "Our Vision of Applied Research" (Ministry of Economic Affairs, 2013d). This paper expresses the intention to make the TO2 institutes more efficient and effective by changing their working methods and operational management. In this view, new and more cohesive working methods are required to programme and execute research, especially research related to the top sectors. The position of the institutes should also be fine-tuned to distinguish them from other public and private players in the innovation system and to preclude unwelcome competition. These ambitions have been translated into five action points:

- a shift from block funding to competitive funding based on quality and impact:
- sharper positioning of the institutes in relation to commercial knowledge providers;
- focus on multi-year public-private partnerships in the top sectors;
- uniform governance structures of the institutes;
- focus on quality and impact of the institutes.

The remainder of this section takes these five action points as points of departure to examine the Dutch government's policy *vis-à-vis* the TO2 institutes.

A shift from block funding to competitive funding

According to the vision document, the government is working towards a situation in which TO2 institutes receive less of a fixed subsidy upfront and, instead, are granted additional funding on the basis of quality, output and impact. Most of the government's contribution to the development of knowledge is from the budget of the Ministry of Economic Affairs. The money is intended for long-term research, research on societal themes, research on policy and statutory tasks, and research for the top sectors. The Ministry of Defence and the Ministry of Social Affairs and Employment also fund research for the development and maintenance of their own specific knowledge base. The Ministry of Social Affairs & Employment involves the social partners (employer and employee organisations) in the programming for the TNO research on working conditions. Various government bodies also outsource contracted research to TO2 institutes.

Table 5.15 shows that direct government funding of TO2 institutes has been in decline since 2008 and will continue to fall in the next few years. By 2016, it is expected to have fallen by about a quarter from 2008 levels. This will mean that TO2 institutes will receive on average only about one-quarter of their income through direct funding by 2016 (compared to around one-third today). This level of direct funding is low by international standards – for example, the Fraunhofer institutes in Germany, which bear some resemblance to the Dutch TO2 institutes, receive on average around one-third of their income through direct government funding. For other PRIs in Europe, the proportion can be much higher. The TKI allowance is intended to supplement the lower levels of direct funding on offer, but this amounted to only EUR 38 million in 2013 for the TO2 institutes (Table 5.16) and on its own will not compensate for the loss of direct funding. This is a major cause for concern: for example, businesses participating in the HTSM TKI have expressed alarm at the erosion of direct funding in the TO2 institutes.

Table 5.15. Direct government funding for TO2 institutes*

Million EUR

Institute	2008	2009	2010	2011	2012	2013	2014	2015	2016
MARIN	4.5	4.4	4.3	4.3	4.8	4.6	4.6	4.6	4.6
TNO	214	196	195	197	186	173	165	160	156
NLR	25	25	26	26	26	25	23	22	21
DLO**	179	185	181	169	162	150	141	138	137
ECN	32	30	31	24	23	25	22	18	18
DELTARES	16	16	14	13	12	12	11	10	10
Total	**471**	**456**	**451**	**433**	**414**	**390**	**367**	**353**	**347**

*Standard contribution by the government, excluding incidental subsidies. No account is taken of the policy tasks of the Rutte 2 government or the pay and price adjustments after 2012. Various institutes receive additional funding from government bodies for specific policy tasks. Policy and statutory tasks are included in the direct government funding for DLO and, to a lesser extent, for TNO (2/3 of the funding for DLO).

**Figures for DLO include VAT.

Source: Ministry of Economic Affairs (2013d), "Our Vision for Applied Research" (in Dutch).

Table 5.16. Recipients of the TKI allowance

Key Sector	TKI-Allowance	NWO, Universities, Institutes		TO2 Institutes		SME Innovation and Network Activities, TKI		Overhead
		Amount	Share	Amount	Share	Amount	Share	
Agri&Food	8 595 779	3 187 503	37%	2 955 693	34%	1 952 582	23%	500 000
Chemicals	11 787 859	9 562 837	81%	961 920	8%	400 000	3%	737 423
Creative industries	60 050					60 050	100%	
Energy	8 179 750	4 719 270	58%	1 642 130	20%	1 768 000	22%	50 000
High-tech systems	28 139 821	2 950 000	10%	22 210 000	79%			700 000
Life sciences	8 000 000	7 750 000	97%			250 000	3%	
Logistics	1 680 147	1 680 000	100%					
Horticulture	5 094 984	2 955 350	58%	1 094 111	21%	979 365	19%	66 000
Water	11 690 395	1 501 642	13%	9 338 551	80%			765 098
Total	83 228 785	34 306 602	41%	38 202 405	46%	5 409 997	7%	2 818 521

Source: Ministry of Economic Affairs (2013b), Enterprise Policy Monitor Report.

Also significant are changes in the mechanisms for allocating direct funding following the recommendations of the Commission Wijffels report in 2004 (Box 5.13). The new arrangements, known as "demand programming", were introduced in 2007 and have seen an increasing government role in determining how direct funding is spent by TO2 institutes. In the case of TNO, this resulted in agreements on the use of the programme funding along 12 themes of national priority (TNO, 2010). The new arrangements were meant to give the ministries greater influence in directing research questions to the TO2 institutes, to stimulate structural changes in the TO2 institutes that make them more receptive to demand, to improve articulation of demand in ministries, and to promote greater involvement of business.

Box 5.13. Recommendations of the Commission Wijffels (2004)

In 2003-04, an *ad hoc* advisory commission (Ad hoc Commission Wijffels) evaluated the bridging function of TNO and the five Large Technological Institutes (GTIs) in the Dutch knowledge landscape. The Commission was asked to describe the changing context in which the applied research institutes operate – especially in relation to their bridging function between more fundamental research and industry and society – and to advise on demand articulation, production, diffusion and utilisation of knowledge derived from fundamental and more applied research. The Commission concluded, among other things, that:

- The direct links between demand and supply of knowledge needed to be improved and strengthened.
- New direct links between actors had emerged and changed the context in which the applied research institutes operate, making their bridging function obsolete.
- Demand-led steering of knowledge institutes needed to improve. The research institutes should be conceived as knowledge firms that are partly financed by government. In this context, a distinction was proposed between the market function of the applied research institutes (i.e. performing contract and project research for public and private parties) and the task function (i.e. long-term research programmes on themes selected by government). On the latter, these included much-needed knowledge investments for which no immediate and/or completely articulated market demand could be expected.
- A coherent, co-ordinated and strategic vision for the applied science knowledge infrastructure in the Netherlands was lacking. It was advised to take the distinction between the market function and the task function of TNO and the GTIs as a point of departure, to provide guidance, in co-operation with industry and societal organisations, on direction in which the institutes need to develop; to provide TNO and GTIs subsequently with enough room to realise this ambition and to evaluate regularly the progress the institutes make and the knowledge contribution they provide (both from a societal and economic point of view).
- A central co-ordination function needed to be created within central government to implement and monitor the proposed changes as well as to manage the use of public funds for applied research. Ultimately the persistent use of demand-led steering and financing should result in a dynamic process of renewal and adaptation within the knowledge infrastructure at large.

Source: Boekholt, P and den Hertog, P (2005), "Shaking up the Dutch innovation system: How to overcome inertia in governance", in OECD (2005), *Governance of Innovation Systems, Volume 2: Case Studies in Innovation Policy*, OECD, Paris.

These arrangements have now been largely replaced by the top sectors approach, which brings together the government, institutes and businesses to engage in collective programming (see below). An evaluation conducted in 2011 (den Hertog *et al.*, 2011) identified some of the successes and challenges of the demand programming arrangements, which are likely to be pertinent as well for the top sectors. It made the following observations:

- The arrangements had strengthened the relationships between the various government departments and TO2 institutes and introduced an improved, structured dialogue on the research agenda. They had also contributed to organisational changes in the TO2 institutes, notably the adoption of themes for better linking research activities to socioeconomic issues.
- Government sometimes had difficulties articulating demand, particularly at levels of abstraction beyond tasks associated with a clear departmental responsibility. For example, in thematic areas where government has no specific public task to perform or where a public-private dimension is important, demand articulation was more problematic. This was also the case in instances in which government has responsibility for system stewardship, such as the preservation of the TO2 institutes within the knowledge and innovation landscape.
- Too little attention had been paid to the impact of the arrangements on departments' utilisation of research results generated by the TO2 institutes.
- Involving companies and civil society organisations in the process had been problematic, since they tend to be more interested in discussing concrete projects than issues at the level of abstraction that marks discussions in the demand programming process.
- The new arrangements had not provided a structural solution to the problem of sustainable funding of the large research infrastructures housed in the TO2 institutes. Some of these, like the wind tunnels of the National Aerospace Laboratory and the Delta Flume of Deltares, are massive. They are often expensive to run and cannot be financed from routine exploitation.
- Finally, a uniform design of demand programming arrangements is both impossible and undesirable on account of the variety in the nature of the tasks and theme areas covered and the associated roles and responsibilities of the government.

Greater involvement of business in the top sectors is expected to improve articulation of demand. In light of budget cuts, the government also hopes that business will make financial contributions to the knowledge base of the TO2 institutes. However, there are risks and challenges associated with this. First, it is important to recall the purpose of block grant funding: to provide a sound knowledge base that can be used to address immediate questions and to anticipate future questions and that allows the TO2 institutes to support the government in its policy and statutory tasks. While this type of research is inspired by questions from the field, the immediate aim is not always to find solutions to today's questions. So this sort of long-term knowledge base is essential to the TO2 institutes, but the extent to which business support will be forthcoming is unclear.[31] Second, independence is an important aspect of TO2 institute research that supports the public interest or the implements public tasks. Yet, there is a risk that involving the business community in this aspect of TO2 institutes' research activities will compromise their independence. To be fair, these challenges and risks are recognised by the Dutch government, but it is not clear how they will be managed over the coming years as funding cuts really begin to bite.

Besides business, EU funds offer a source of income for the TO2 institutes, which might plug some of the funding gaps left by reduced levels of direct government funding. In fact, the TO2 institutes are already extraordinarily successful in obtaining EU funding: according to the Ministry of Economic Affairs vision document, between 2007 and 2010, the institutes were allocated EUR 211 million in projects of the EU's Seventh Framework Programme (FP7). The success rate of the TO2 institutes was 30% – higher than the national and international average (see Section 5.8). On the face of it, this is a resounding success, and has the added benefit of making knowledge from Europe available in the Netherlands. But it also reflects flat or decreasing levels of national funding, so that institutes have turned to Europe perhaps more out of necessity than opportunity. There are risks associated with such a situation: for one, there could be a lack of alignment of national goals and European funding programmes, which could either make European funding unattractive or, if successfully applied for, divert the institutes' attention from national goals. This might not be bad in some situations, as it can support diversity in research. Too much diversity can, however, make strategic management of institutes difficult, and there is a genuine risk of developing a fragmented and sub-critical knowledge base. Indeed, such phenomena are not uncommon in systems whose block funding has been scaled back (too far) and institutes have felt the need to chase multiple sources of (often small-scale) funding to fill the gaps. This risk would seem to apply especially to TNO, which is by far the largest recipient of EU funds among the TO2 institutes and already pursues the broadest set of research activities.

Sharper positioning of the institutes

With a view to precluding unfair competition in markets for knowledge services, another key action point of the government's vision document is to demarcate more clearly the playing field in which the TO2 institutes may operate. The government believes that the TO2 institutes sometimes operate in the same areas as private knowledge providers, which disrupts markets. Demarcating clearly defined market positions that distinguish the TO2 institutes from private knowledge providers is complicated by the fact that the institutes operate at the public-private interface and work closely with end users, for example through the top sectors, to maximise the relevance of their research. Furthermore, the top sectors approach adds to this risk in some sectors: while the institutes must engage in research that will benefit the top sectors, if the programming for top-sector research brings the institutes into the territory of private knowledge providers and market players, the risk of unfair competition will increase. The government recognises the risks and has drawn up a set of ground rules that define where the role of government-funded TO2 institutes ends and the role of market players begins. There is one set of rules for government-funded research and another for contracted research (see Box 5.14). The institutes are expected to apply these rules when they formulate and implement their strategic plans and are primarily responsible for ensuring that the rules are adhered to.

Box 5.14. Ground rules and rules of behaviour laid down for TO2 institutes

Rules for government-funded research intended for building knowledge bases:

- Government-funded research must be precompetitive (it must not directly lead to a ready-made end-product for a business).
- The institutes must not develop knowledge that is already available in sufficient depth in the market.
- Intellectual property policy must be aimed at low-threshold access to knowledge for private parties.
- Institutes must be transparent about their research programmes.

Rules for contracted research and the rental of facilities by third parties:

- Synergy between the aims of the institute and the government-funded research must be evident in the activities.
- Where possible, routine activities that can be performed in the market should be shelved.
- Always a minimum overall cost price for contracted research.
- No cross-subsidies, separate bookkeeping.

The government has an exclusive relationship with the TO2 institutes for certain themes.

Rules for spin-offs (new businesses arising from TO2 institutes):

- Spin-offs must be offered first to market players in compliance with the market.
- Spin-offs from institutes must have a clear status. They are either part of the institute or they operate as a market player. A spin-off that operates as a market player may not benefit any more than other market players from a relationship with the institute where it originated.

Preconditions

- Rules of behaviour must be clear; they must not lead to litigation. Investments must be made in collaboration and there must be mutual trust.
- The playing field is dynamic. The precompetitive technology of today is the competitive technology of tomorrow. Continuous maintenance and co-ordination is therefore essential.
- Societal interests and statutory tasks may lead to the development at TO2 institutes of knowledge that is also available elsewhere. This is unavoidable and is necessitated by considerations relating to independence, security regulations, availability and direct access to the knowledge.

Source: Ministry of Economic Affairs (2013d), "Our Vision for Applied Research" (in Dutch).

Focus on PPPs in the top sectors

The TO2 institutes have a long tradition of working with and for the private sector; supporting the private sector was, after all, a chief rationale for setting them up in the first place. The private sector funds much of the research carried out in the institutes. In TNO, for example, assignments from the business sector amounted to EUR 252 million in 2012, or 43% of all income. The private sector has also been involved in shaping the broader research agendas of the institutes. Again taking TNO as an example, the private sector, together with other stakeholders, has participated in the so-called "knowledge arenas" that advise TNO on its thematic research programmes. Business has also been involved in the "demand programming" arrangements described earlier, though the evaluation (den Hertog *et al.*, 2011) pointed to mismatches between the high level of abstraction of such agenda-setting processes and the more near-term and concrete interests of firms.

The recent introduction of the top sectors approach is therefore the latest incarnation of business shaping institutes' research agendas. It also builds on the demand-driven programming arrangements previously enacted. However, the changes being introduced are more radical than anything that has gone before, recasting both the governance and funding of the TO2 institutes. Under the new regime, a substantial share of the budget for applied research is allocated for research projects executed in one or several top sectors (Table 5.17). For example, a large part of TNO's government funding in 2014 (amounting to EUR 95.3 million) will be distributed across the various top sectors, as shown in Figure 5.11, with the high-technology systems and materials (HTSM) top sector accounting for around one-third of this spending.

In terms of governance, business is now expected to play a leading role in articulating demand for TO2 institutes' research, a role previously largely played by the government. The top sectors' TKIs fulfil this role with their roadmaps, which outline a short- to medium-term research agenda for the fields they cover, followed by joint programming in the form of innovation contracts. The TO2 institutes play a key role in compiling the top-sector roadmaps and in formulating joint programmes, working together on an equal footing with businesses, other knowledge institutes and the government. There are two components to the programming that results: public-private partnerships (with a target of EUR 150 million in 2015, with additional private co-financing); and "private-public-programming" within the TKI innovation contracts (with a target of EUR 100 million in 2015).

Table 5.17. Expected financial contributions of TO2 institutes to top sectors

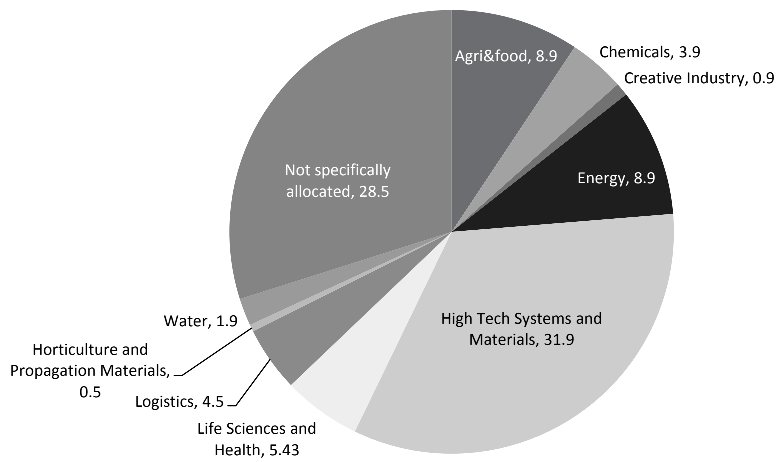
EUR millions

	TNO	DLO	Deltares	ECN	Marin	NLR	Total
2012	94.1	51.0	3.8	17.1	3.7	7.8	**177.5**
2013	91.8	51.0	5.5	16.4	3.7	7.4	**175.8**
2014	95.3	52.5	10.2	15.4	3.7	5.2	**182.3**
2015	88.8	47.2	8.8	14.1	3.4	5.2	**167.5**

Source: Nederlands Kennis- en Innovatiecontract 2012-2013 and 2014-2015, Annex to Monitor Bedrijvenbeleid: Bedrijvenbeleid in Beeld 2013, Ministry of Economic Affairs.

Figure 5.11. TNO's expected financial contributions to the top sectors in 2014, by individual top sector

EUR millions



Source: Nederlands Kennis- en Innovatiecontract 2014-2015, Annex to Monitor Bedrijvenbeleid: Bedrijvenbeleid in Beeld 2013, Ministry of Economic Affairs.

Table 5.18. Three variants of public-private partnerships (PPPs) involving the TO2 institutes

Variant 1: Programmes	Variant 2: Large projects	Variant 3: Short-term projects
*Large consortia *Duration > 4 years *Private contribution depending on nature of research: at least 10%, target ascending over time up to more than 50%. *Top team assesses whether the programme fits in innovation contract / roadmap, can delegate to TKI and/or Institute *Third-party membership after start is possible in principle. Conditions can be set and rejection is possible on the basis of reasonable arguments *Combination of fundamental and industrial research is possible	*Large/medium consortia with a minimum of 2 companies *Duration: 1-4 years. *Private contribution depending on nature of research in participating companies. Target is more than 50% *Top team assesses whether the project fits the innovation contract / roadmap, can delegate to TKI and/or institute *Accession of new partners during project's term permitted, with approval of consortium *For the most part, industrial research, possibly some fundamental research and/or experimental development	*Small consortia, possibly with 1 company, but preference for at least 2 *Duration: less than 1 year *Private contribution depending on nature of research. Targets: fundamental research more than 25%; industrial research more than 50%; experimental development more than 75% *Top team assesses whether theme in innovation contract/roadmap fits. TKI and institute design selection process, institute decision on projects and reports to TKI *During project no accession unless this becomes necessary, as deemed by project partners *Usually, industrial research or experimental development, but can also be short-term fundamental research

Source: Spelregels voor privaat-publieke samenwerking bij programmering en uitvoering van fundamenteel en toegepast onderzoek, Advies van de Regiegroep Spelregels, June 2013 (in Dutch).

On public-private partnerships, the "rules of the game" discussed earlier also apply to the TO2 institutes, though with different arrangements than for the fundamental research funded by NWO. For applied research, there are three variants of PPPs for the institutes to use (Table 5.18). In contrast to the variants for fundamental research, the variants for applied research are defined largely by the duration of the partnership, ranging from programmes of more than four years duration to short-term projects of less than one year. Overall, the aim is to work more in multi-year programmes or in the form of an institute, such as the Holst Centre (see Box 5.15). The government hopes this will enhance synergy in top-sector-related activities, show businesses how to give direction and join in, and prevent the TO2 institutes from being drawn away from the market by incidental projects. The government also expects the institutes to organise themselves flexibly to meet the needs of the top sectors: any mismatches between the required and available competencies and knowledge for a top sector will need to be dealt with by agreeing on a clear transition path.

Box 5.15. Holst Centre – an example of a long-term public private partnership

The Holst Centre is an independent research centre which seeks to advance the fields of wireless autonomous sensors and flexible electronics. It was founded in 2005 by Imec, a Belgian nano-electronics research institute, and TNO, with support from the Dutch Ministry of Economic Affairs and the Government of Flanders. Its budget draws on a mix of public funding, industrial partnerships and EU projects. More than half of the centre's funding comes from industry. Over 180 employees from 28 countries work at the centre. Based at Eindhoven's High Tech Campus, it has over 200 office spaces and small laboratories and manages a clean-room environment with a roll-to-roll research line for large-area printing and coating of systems-in-foil. This facility allows for the demonstration of a complete flexible-electronics manufacturing process.

Following open-innovation practices, the Holst Centre has several types of partnerships with industries and universities with shared roadmaps and research agendas. It has a framework agreement with Delft, Eindhoven and Twente universities of technology (3TU) and KU Leuven. In parallel to their research position at the centre, several staff members work as part-time professors. The Holst Centre has also built a track record of collaboration with SMEs. For example, it has signed a participation agreement with DevLab, a research platform initiated by 12 SMEs specialising in wireless network protocols; and NeoDec, a spin-off from Eindhoven University of Technology has entered the Holst Centre partner network to share its capabilities in low-temperature processing of conductive structures on flexible substrates. Other SME partners with past and current projects include: InnoPhysics, IntrisicID, Maastricht Instruments, iKnow, Singulus Mastering and Target Compiler Technologies. Through these strategic partnerships, the centre aims to fine-tune its scientific strategy tailored to industrial needs.

Source: Holst Centre website, www.holstcentre.com.

These arrangements somewhat restrict the autonomy of the institutes to formulate their own research agendas, and there are concerns that they will lead to shorter time horizons and insufficient investment in infrastructure and development of competences (along the lines in the discussion above on erosion of block funding). The government hopes that strengthening the links between applied and fundamental research will offset any tendencies towards short-termism and will help ensure that the institutes' knowledge is continuously renewed and updated through the application of the latest fundamental research. In this regard, the "rules of the game" document provides concrete proposals for integrated (fundamental-applied) programming involving NWO and the TO2 institutes. However, the extent to which such arrangements can compensate for reductions in dedicated investments in the TO2 institutes' knowledge base is unclear. In sum, it will be important to monitor closely the impacts of the top sectors on the TO2 institutes, bearing in mind that, like their fundamental science counterparts, they require a certain level of stability and continuity, as well as a long-term perspective, to invest in core competences and infrastructure.

Harmonising working methods and management structures across the institutes

The government believes there is scope for greater co-operation among institutes, at least at the strategic level; it would be facilitated by the adoption of more uniform steering and working methods. The TO2 institutes operate in different ways at present. These differences have evolved over time and are a legacy of the days when they were run by different government bodies. They were also set up on different legal grounds: TNO was established by an Act of Parliament – which makes it an independent public body; DLO is a legal body with a statutory remit; and the GTIs are private foundations. The government believes that harmonisation of working methods could help clarify matters for businesses in the top sectors, for example, that collaborate with different institutes.

Since 2010, the institutes have been united in the TO2 Federation (see Box 5.16) and often work together; at the same time, joint programming in the top sectors has already improved co-ordination among institutes. The government would like the institutes to step up their collaboration and has asked them to draw up a collective strategic plan stating how they could work better together, where they could co-ordinate and share activities more effectively, how they could approach their target groups together (including the top sectors), where they could realise efficiency gains, and how they could learn from one another's strengths. In the meantime, the government intends to look into the desirability of incorporating all the institutes within one legal framework while giving due consideration to the specific interests of government bodies. Wholesale reorganisation of the institutes appears not to be on the agenda for the time being, given the significant amounts of time and energy this would consume, not to mention the disruption. This position seems sensible. At the same time, it will be important for the government to acknowledge the obvious limits to co-operation and harmonisation given the institutes' rich variety of activities and relationships.

Box 5.16. The TO2 Federation of applied research institutes

Through the TO2 Federation, the six Dutch research institutes for applied research have joined forces to deliver added value in the field of applied knowledge. Specifically, their co-operation is intended to lead to better visibility of the infrastructure of applied knowledge, nationally and internationally; further strengthening of demand-driven research by TNO and the GTIs run for business and government; a more efficient deployment and use of large-scale research facilities of the partners; and an increase of (technological) start-up and spin off companies in order to exploit knowledge.

Source: Rathenau Institute.

Evaluating quality and impact

The TO2 institutes have various evaluation and monitoring arrangements that help them improve their performance. However, there is no standard approach across institutes or much in the way of whole-institute evaluation. This is surprising given the standard arrangements already in place to evaluate the universities and NWO and KNAW institutes. It makes it difficult for the government to understand the outputs of the institutes and their quality and impacts. The government feels it needs to get a tighter grip on the quality and output of the institutes as a basis for steering and accountability. To this end, it intends to introduce more uniform monitoring, measurement of effects, and evaluation arrangements for the TO2 institutes. Every four years, starting from 2015, the effectiveness and quality of the institutes will be evaluated and compared, using the same criteria and procedure. The scope of the evaluation will include the quality of the research, the impact on policy and society, and the impact on the economy. Evaluations are expected to provide a clearer idea of how the capacity of the institutes is distributed across long-term research, top-sector research, and research for societal and policy issues, and of the synergy between them. Evaluation results will then be used as an input in determining the allocation of funding for the next four years.[32]

These proposals are broadly welcome and should also help the TO2 institutes better demonstrate the value of their activities to government ministries and other stakeholders. At the same time, it will be important for the evaluation criteria to take sufficient account of the full range of activities and outputs of the institutes and not rely overly on crude indicators, a particular risk when aiming for measurement standardisation across institutes. The proposals hint at a mixed quantitative-qualitative approach that includes site visits, which would seem to promise a more rounded assessment than would be possible if relying solely on quantitative indicators.

5.7. The regional dimension

Dutch regions in the national and international context

Inequality in terms of GDP per capita is relatively low in the regions. The Gini coefficient – a standard measure of inequality – across Territorial Level 3 (TL3)[33] regions (OECD, 2013d, Annex 1.A1) is below the OECD average (0.12, compared to 0.16 in 2010). In only a few countries is inequality among regions less, with the lowest in Sweden (0.07). However, as in most OECD countries, this index increased between 1995 and 2010 (OECD, 2013d). The Netherlands' relatively low level of inequality among regions is related to the poly-centric nature of the Dutch economy. All regions contribute to national economic growth. The provinces of Zuid-Holland, Noord-Holland, Noord-Brabant, Utrecht and Gelderland together account for 75% of national economic growth (1995-2009), but no single province contributes more than 20%, a proportion much lower than generally observed in OECD countries (OECD, 2014c). The impact of the financial crisis differed in the regions: the southern areas of the Netherlands were hit the hardest; regions and provinces in the north, such as Groningen, Flevoland or Noord-Holland, fared better (Statistics Netherlands, 2013).

Dutch regions compare well to OECD average innovation intensity. The southern area of the country, in particular, hosts global innovation hubs. The EU Regional Innovation Scoreboard (European Commission, 2012) ranks Dutch provinces among *innovation leaders* (the provinces of Utrecht, Noord-Holland, Zuid-Holland and Noord-Brabant), *followers* (Groningen, Overijssel, Gelderland, Flevoland, Limburg) and *moderate* (Friesland, Drenthe, Zeeland), with no region in the *modest* category.

As in other OECD countries, innovation-related performance varies across regions (Table 5.19). While the levels of R&D investments and skilled personnel tend to vary less across regions than in most OECD countries (partly owing to the small number of Dutch regions), the variation in patenting intensity is pronounced (it is higher only in Germany, the United States and Switzerland). Eindhoven, in the region of Southern Netherlands, had the highest patent intensity in the OECD area, with around 2 200 patents per million inhabitants in 2008, ahead of San Diego and San Francisco (United States). Dutch regions such as the Northern and Southern Netherlands rank high in terms of production of scientific publications in top quartile journals, owing to the presence of leading HEIs in those areas (OECD, 2013d).

Table 5.19. Dutch TL2 regions: economic and innovation-related variables

	Northern Netherlands	Eastern Netherlands	Western Netherlands	Southern Netherlands	National averages
GDP per capita (2010, USD PPP, current prices)	40 549	35 051	44 929	40 225	41 368
Total R&D expenditure (GDP %, 2009)	1.17	1.84	1.82	2.23	1.82
Business R&D expenditure (% of GDP, 2009)	0.44	0.81	0.63	1.69	0.86
Percentage of the labour force with tertiary education attainment (2012)	27.74	29.23	35.39	29.60	32.10
R&D personnel (% of employment, 2009)	0.76	1.17	1.27	1.38	1.22
Patent intensity (PCT per capita, 2008-10 average)	56.18	104.72	124.32	489.87	193.57

Source: OECD Regional Database. [PCT = Patent Cooperation Treaty]

Historical evolution of regional innovation policy in the Netherlands

In most OECD countries, regional development policy was originally meant to target marginalised or lagging areas at a country's periphery. Policy and instruments were essentially designed to transfer resources from wealthier to less developed areas, in order to limit or reduce regional disparities in socioeconomic performance. However, since the late 1990s a new paradigm for regional development has emerged: resource-transfer mechanisms from more to less developed regions were replaced by a set of integrated cross-sectoral initiatives that support regional development by investing in local strengths and assets. OECD regions have progressively adopted such initiatives and the paradigm shift from subsidies to investments has put innovation policy at the core of regional development agendas in most OECD countries (OECD, 2011). In Europe, the increasing emphasis in EU programmes on regional innovation efforts has contributed significantly to this shift.

The evolution of regional development policy in the Netherlands in the post-war period is presented in Table 5.20. The Netherlands adopted the above-mentioned paradigm shift in the mid-2000s with the launch of the "peaks in the delta" strategy (OECD, 2014c), a national policy with a territorial focus. It was based on six local development strategies, which identified opportunities and challenges in each regional innovation system on the basis of existing strengths and clusters of activities. The six regional development strategies focused on a number of different sectors (such as energy, water, life sciences, high-technology systems) with a strong emphasis on innovation, competitiveness and international networks. The initiatives related to peaks in the delta (2004-11) were jointly funded by the Ministry of Economic Affairs, the European Structural Funds and regional authorities.

Table 5.20. Regional development approaches in the Netherlands: Historical overview

Year	Policy document	Chosen instruments
1947	Welfare Plan for South East Drenthe	Marshall Fund investments in mechanisation of peat extraction, research on peat chemistry, business site creation
1950	Regional Development Plans	Government subsidies for the development of new businesses in a limited number of regions
1953	Promotion of Industrialisation of core local authorities (BIK)	Subsidies for investment in establishing facilities; subsidies for highly skilled workers
1959	Promotion of Industrial Development (BIO)	Subsidies for the establishment of new business locations and the development of new business parks
1964	Stimulation of Industry Location in Development Areas (SIO)	Subsidies for the establishment of new business locations and cost reductions for locating in new business parks (more flexible than the BIO)
1969	Investment Premium for Industry (IPR)	Support for industrial investment, including government and provincial guarantees for high risky-reward investments
1973	Den Uyl's programme to address the crisis	Limiting growth in South Holland, relocating government offices, integrated structure plans for eastern and southern regions, creation of the regional development agencies (ROMs)
1980	Regional Socioeconomic Policy 1981-85	National support for regional partners' investments in regional growth opportunities
1985	Regional Socioeconomic Policy 1986-91	National support for regional partners' investments in regional knowledge-based growth opportunities, such as innovation centres, science parks, liaison offices
1990	Regions without borders: regional economic policy 1991-94	Focus of national investments on the main Dutch ports to stimulate the international competitiveness of all Dutch regions
1995	Space for regions: spatial-economic policy to 2000	Investments in all regions; optimising the use of European Structural Funds in the Dutch regions
2000	Compass Programme	Special investment programme using Hydrocarbon Funds to invest in knowledge economy in North Netherlands
2004	Peaks in the Delta	Investment in region-specific investment plans in six regions
2010	*Decentralisation of regional economic policy*	Abolition of the Peaks in the Delta programme; devolution of responsibility for regional economic policy to provinces (unfunded mandate)

Source: OECD (2014c), *Territorial Review of the Netherlands*, OECD Publishing.

An evaluation (commissioned by the Ministry of Economic Affairs) of the effectiveness and the efficiency of the peaks in the delta strategy was positive overall (Geerdink et al., 2010). It found that it received positive feedback both from programme beneficiaries and regional actors involved in its implementation. In addition it highlighted several positive effects related to the implementation of the programme: stronger collaboration between the ministry and local authorities; the increasingly important role of regional development agencies; the programme's effectiveness in evaluating proposals and offering grants.

Pressures for fiscal consolidation, and a related reduction in direct state intervention, resulted in the termination of this strategy following a change in government. Major reasons for the termination were the absence of strong thematic steering of territorial development policies from the national level and concern that decentralisation could favour a proliferation of local spending agreements.

In 2010, the peaks in the delta strategy was replaced by the top sectors approach.[34] Most of the sectors targeted by the regional development strategies under the former are mirrored in the top sectors. However, the top sectors approach shifted policy focus from regions (regional and territorial development) to sectors (support to sectors selected nationally, irrespective of location). Even if the new policy limited sub-national responsibilities for innovation initiatives, leading regional and local actors are considered important for the success of the top sectors (especially in locations in which top-sector activities are concentrated). This gives the policy a *de facto* spatial dimension, depending on the presence (or absence) of strong top-sector clusters in specific locations. A recent study mapping top-sector clusters in the Netherlands shows that they are particularly concentrated in the western part of the country (in particular in the provinces of Noord-Holland, Zuid-Holland and Noord-Brabant) and in the areas around Eindhoven, notably with respect to the high-technology systems sector (PBL, 2013).

According to the Ministry of Economic Affairs (2011), regional and local authorities play an active role in the top sectors approach, especially for the support and promotion of leading regional clusters, SMEs, human capital and lifelong learning programmes. In particular, the south-east (with the Brainport2020 strategy, see below) and the northern wing of the Randstad have been identified as key contributors to the national top-sector agenda owing to the concentration of top-sector-related activities in these territories (PBL, 2013). Several instruments associated with the top sectors have a clear regional dimension: the SME+Innovation Fund, the centres of expertise, innovation-oriented procurement and the human capital agenda. Each region also has a regional Technology Pact that contributes to the national Pact.

The top sectors agenda increasingly acknowledges the importance of a continuing dialogue between sub-national actors and the central government. Since this policy approach was adopted in 2010, the role of regional and provincial authorities in the top sectors is taken into account. The goal is to strengthen vertical co-ordination and to promote innovation dynamics not only through a top-down approach (from the central government to regions) but also through bottom-up initiatives. Two recent documents have also mentioned the importance of regional approaches for capturing opportunities arising from local actors (WRR, 2013) and the need to strengthen the national-regional dialogue in the framework of the top sectors approach, given the potential leverage action of regions (AWT, 2013), especially in some areas of innovation policy aimed at SMEs. Potential risks of misalignment relate to duplication, omissions, fragmentation, conflicting rules in programme design and implementation. The involvement of regional representatives in formal or informal steering groups associated with the top sectors could be a way to ensure effective co-ordination and to take the needs of local actors sufficiently into account. However, alignment between the top sectors and regional agendas is particularly suitable for regions that are highly specialised in the top sectors but less so for areas specialised in other industries. The development of regional smart specialisation strategies is an opportunity for all regions (both those more and those less specialised in the top sectors) to specifically target their strengths and assets (see below and Box 5.17).

In addition to vertical co-ordination, the top sectors approach may be an opportunity to strengthen inter-regional co-ordination in selected sectors on the basis of the definition of functional (rather than administrative) areas for innovation activities. It may also help to strengthen cross-sectoral co-ordination at the local level to promote synergies and innovation at the intersection of several sectors. Recent research indicates that regions characterised by higher "related variety" (i.e. a concentration of firms in similar but not identical sectors) have higher employment growth rates.[35] By involving regional actors, the top sectors approach can promote dialogue and synergies across firms located in contiguous areas and operating in different top sectors in order to identify opportunities for innovations that bridge several thematic areas. In addition, inter-regional co-ordination may reduce the risk of disconnecting peripheral innovative clusters or firms from the core areas of activity in related industrial or technological fields. In the top sectors agenda, it is important to promote the design and implementation of instruments and programmes that effectively promote inter-regional and cross-sectoral co-ordination.

Regional approaches – agendas and instruments

European funding and the proceeds from privatisations in the energy sector have provided opportunities for Dutch regions to develop, fund and manage regional innovation programmes, instruments and facilities. Over successive EU programming periods, regional innovation policies have gained in importance. In the programming period 2007-13, regional competitiveness was considered a key aspect of the European cohesion policy agenda. Except for regions listed under the convergence objective (the least developed EU areas), all remaining regions (including all regions in the Netherlands) were listed under the regional competitiveness and employment objective. Regional innovation, as a driver of economic growth and job creation, has been considered an enabler of regional competitiveness. Dutch regions contributed to the European regional competitiveness agenda through the strategies and programmes developed under the peaks in the delta strategy. During the programming period 2014-20, innovation will be even more central to the EU regional agenda (with the so-called smart specialisation strategies). Each of the North, East, South and West regions is to develop a research and innovation for smart specialisation strategy (RIS3) as a prerequisite for innovation funding from ERDF (European Regional Development Fund). The degree of connection between the different strategies and the top sectors agenda varies depending on the region and its socioeconomic pattern and industrial specialisation. Most strategies were developed in consultation with representatives of the so-called "triple helix" of business, knowledge institutes and government (Box 5.17).

Box 5.17. Regional innovation strategies in the Netherlands

The Region of Southern Netherlands developed a RIS3 strategy mainly based on the *Brainport 2020* Strategy (*Brainport 2020 – Top Economy, Smart Society*). The region is specialised in the following sectors: high-technology systems and materials, chemistry/life sciences, agro-food, logistics and creative industries. Some of these clusters are part of the top sectors. Various stakeholders took part in a consultation process that resulted in the development of the strategy. The Southern Netherlands has a tradition of open innovation and international collaboration and the strategy aims to develop initiatives that are well integrated in European networks and programmes. This region is also engaged in several cross-border activities to maximise knowledge spillovers arising from a functional regional innovation approach

The Region of Western Netherlands launched the RIS3 strategy *Chances for the West,* developed in consultation with representatives of the so-called triple helix. This strategy is strongly connected to the top sectors agenda, in relation to the fact that, according to PBL (2013), many top-sector clusters are concentrated in this region. The strategy's goal is to increase private investments in R&D and knowledge valorisation. Attention is also paid to crossovers between top sectors, in particular as a source of innovation to meet societal challenges.

The Region of Northern Netherlands developed a strategy largely based on the results of an analysis carried out by the University of Groningen, which identified the following sectors on the basis of specialisation, mass and growth potential in the region: agribusiness, life sciences/health care, sensor technology and water. The strategy has a particular focus on SMEs and crossovers among sectors. A SWOT exercise was part of the analysis. It showed that in Northern Netherlands only 30% of economic activity is related to clusters or top sectors. Therefore the region has chosen to specialise in different activities. However, it will develop regional programmes targeting focus areas in line with the human capital agenda of the top sectors.

At the time of writing, no RIS3 strategy was available for the Region of Eastern Netherlands.

Source: ERAWATCH, regional websites.

Box 5.18. An example of cross-border collaboration on innovation: The Top Technology Region/Eindhoven-Leuven-Aachen Triangle (TTR-ELAt)

TTR-ELAt supports cross-border collaboration on innovation, covering the area at the intersection of three countries (the Netherlands, Germany and Belgium) that includes four regions and six provinces. The area has a population of over 8 million inhabitants and hosts a dense network of innovation actors: from universities to knowledge-based industries and services firms. Philips in Eindhoven, together with other large R&D intensive multinationals, and the IMEC research centre in Leuven (Belgium) are among the leading actors to promote open innovation and high-technology initiatives in the region. The area has a long tradition of cross-border policy collaboration (since the 1970s), with the aim of achieving critical mass in innovation activities and better exploitation of knowledge complementarities.

TTR-ELAt has developed a mix of policies targeting the cross-border area with a "variable geometry" partnership approach. Examples of cross-border initiatives include: the Holst Centre (a joint research centre funded by IMEC in Flanders and TNO in the Netherlands – see Box 4.15), the forthcoming Biomaterials Research Centre (a joint Dutch-German initiative), the GCS Cross-border Cluster Stimulation programme (distributing grants for cross-border R&D projects involving SMEs), and the Top Technology Clusters (cross-border clusters providing business support and innovation vouchers).

Source: OECD (2013e), *Regions and Innovation: Collaborating across Borders*, OECD Reviews of Regional Innovation. OECD Publishing, Paris. doi: 10.1787/9789264205307-en.

Table 5.21. Examples of innovation instruments in Dutch regions and provinces

Type of instrument	Name	Region	Thematic areas covered
Access to finance (generic or thematic) These instruments promote the availability of financing to firms. They can be in the form of loans, loan guarantees or equity participations. They can target specific sectors or not.	*Loan guarantee*	Gelderland	No specific thematic area required
	Energy Fund	Overijssel	Energy
	Innovation Fund	Limburg	No specific thematic area required
	SME & Techno Fund	Flevoland	ICT, life sciences, health care and biotechnology
Generic grants or subsidies Generic grants or subsidies are in the form of direct grants to promote innovation in firms, often SMEs, for the development of specific innovation projects. Firms active in all sectors are eligible.	*Northern innovation support facility (NIOF)*	Drenthe, Friesland, Groningen	No specific thematic area required
	Operational Programme South Netherlands	Limburg, Noord Brabant, Zeeland	No specific thematic area required
Thematic grants or subsidies Thematic grants or subsidies are in the form of direct grants to promote innovation in firms, often SMEs, for the development of specific innovation projects. Only firms active in selected sectors are eligible.	*Friesland Fernijt IV*	Friesland	Health and welfare, food security, sustainable agriculture and bio-economy, energy and water
	Innovation Grant	Gelderland	Food, health, manufacturing, energy and environmental technology, logistics, creative industry or leisure economy
	Grant agricultural innovation	Noord Brabant	Agriculture
	Grant Makers	Limburg	High-technology manufacturing
	Grant Green Deal Solar Technology	Noord-Brabant	Solar energy
	Subsidy programme bio-based	Zeeland	Green economy, agriculture
	Grants bio-based economy	Noord-Brabant	Green economy, agriculture
Knowledge linkages Instruments aiming to promote knowledge linkages often require the active co-operation of firms and HEIs or PRIs in developing innovation projects. Typical examples are knowledge or innovation vouchers.	*Innovation voucher*	Overijssel	No specific thematic area required
	Proof of Concept Fund	Overijssel	No specific thematic area required
	Grant Knowledge and Innovation	North Holland	Leisure economy, maritime, marine and offshore, health care, agribusiness or renewable energy
	Innovation Voucher	Limburg	Energy, environment

Source: www.antwoordvoorbedrijven.nl/subsidies/innovatie/provincie.

In connection with the regional development and innovation strategies, regional and provincial actors have established their own innovation support schemes (Table 5.21), mostly targeting SMEs, including venture capital or loans to small firms and businesses, higher education institutions and knowledge transfer activities (as in the case of innovation vouchers).[36] Regional instruments vary from region to region and may target different sectors (both top-sectors-related or in other domains): for instance, the energy sector in the province of Overijssel, health-care in Flevoland, tourism in Friesland, solar cell technology in North Brabant or the maritime industry in the province of North Holland. In most cases, regional instruments are in the form of direct measures: grants or subsidies distributed to eligible actors (generally located in the administrative region). However, the provinces of Utrecht and Limburg have defined programmes according to functional rather than administrative areas, including some that cross national borders (see Box 5.18 for an example). Regional and local programmes may offer an opportunity for the emergence of innovative bottom-up activities, not necessarily related to the top sectors. A number of Dutch provinces, for instance, have established investment funds targeting SMEs (such as Noord-Brabant, Gelderland, Overijssel and Limburg) (Ministry of Economic Affairs, 2013).

5.8. Supporting international knowledge linkages

Strategic approaches and national programmes that support international STI co-operation

The Netherlands has a long tradition of international economic and commercial relations, dating from the Dutch East India Company in the 16th century, which has developed into a dense net of relations with the outside world and a concomitant exchange of ideas. Dutch scholars and learned institutions played an important role in the development of modern European scientific research. Dutch cities provided safe havens for thinkers, allowing them to develop their ideas in an environment sheltered from pressures that were prevalent elsewhere. The early Dutch publishing industry helped disseminate new ideas, which did not stop at political borders. In modern times, the Netherlands, with its strategic location in western Europe, has been among the pioneers of European integration.

The Netherlands is acutely aware that success in science, technology and innovation in today’s world requires close links with international knowledge networks in order to attract and retain talent and knowledge-intensive investments (see Box 5.19 on the openness of the Dutch innovation system). While this is true for all countries, it is especially important for small economies and for a “large small” one such as the Netherlands. To address the so-called “grand challenges”, including major environmental, health and food security issues, whose scale and scope extend well beyond national borders, requires active participation in international agenda setting and co-ordinated actions. Given the key role of openness and internationalisation in the Netherlands’ economic development, it is no surprise that most institutions active in STI have dealt with the international dimension in one way or the other, including through dedicated programmes and initiatives with an international scope. The Netherlands is also strongly and successfully engaged in European research policy and participates in the Framework Programmes for R&D and innovation.

Box 5.19 Aspects of the openness of the Dutch innovation system

The Netherlands is among the core countries in the global network of international scientific collaboration (OECD, 2013d, Figure 55). Nearly half of Dutch scientific publications are internationally co-authored. Indeed, the Netherlands stands out in terms of the number of international co-publications (per million population): 1 330 compared to an EU27 average of about 300. For various reasons, the domestic ownership of inventions (measured by patent applications) from abroad (around 30%) is higher than the foreign ownership of Dutch domestic inventions (slightly above 20%) (OECD, 2013d, Figure 60). According to the 2010 Community Innovation Survey, however, the percentage of firms engaging in international collaboration on innovation is around 35% for large firms, significantly below Finland (64%), Belgium (64%) or Sweden (56.5%). It drops to 13% for SMEs only, a share that is considerably below that of most leading OECD countries.

With regard to education, the White Paper of the Ministry of Education, Culture and Science, *Quality in Diversity,* acknowledges that an education system with an "international allure" and research institutions able to attract talent from abroad are key priorities for the Dutch innovation system. Mobility and international experience during education are considered increasingly important for preparing students for the labour market. Previous documents on this topic include the internationalisation strategy, *The Borderless Good* (Ministry of Education, Culture and Science, 2008), which built on the previous strategic agenda for higher education, *The Highest Good* (Ministry of Education, Culture and Science, 2007). The main reasons for a higher education internationalisation agenda are: increasing global competition to attract knowledge workers to the domestic labour market; global challenges requiring global solutions; the increasingly international Dutch labour market; and rising competition with institutions abroad to attract the best students and researchers. More recently, the Social and Economic Council of the Netherlands (SER) has developed an action plan (*Make it in the Netherlands 2013-2016, Action Plan*) in order to attract and retain more international students, highlighting possible measures such as facilitating the learning of Dutch, strengthening the English skills of university instructors and simpler rules for the labour market transition of foreign students. A code of conduct has been developed to encourage the presence of international students in Dutch universities (Box 5.20).

Box 5.20. The code of conduct with respect to international students in Dutch higher education

The *Code of conduct with respect to international students in Dutch higher education* guarantees the quality of the higher education provided to foreign and international students. It specifies the type of services and information that must be provided to international students by higher education institutions. Only students enrolling at educational institutions that have signed the code of conduct are eligible for study visas. The code was revised in 2013 to make it more favourable to international students and to simplify procedures for student exchanges with respect to foreign higher education cycles offered in English. To attract international students to the Netherlands, the Dutch scientific institutes abroad (NWIB) were created to share information about study opportunities in the Netherlands. These institutes act as contact points between students in foreign countries and Dutch universities. NWIB are jointly administered by six Dutch universities (University of Amsterdam, VU University of Amsterdam, Utrecht University, Leiden University, University of Groeningen, Radboud University Nijmegen).

Several national initiatives promote the international mobility of researchers, in particular the mobility grants administered by NWO, KNAW and NUFFIC (Netherlands Organisation for Co-operation in Higher Education). KNAW supports international strategic research programmes, notably between the Netherlands and emerging economies. In 2009, KNAW (in co-operation with NWO) established a joint strategic research partnership with China, resulting in a number of memoranda of understanding to promote joint projects and mobility programmes for researchers. KNAW has also launched a scientific co-operation programme with Indonesia (the Scientific Programme Indonesia-Netherlands) to promote collaborative research, sponsor student and researcher mobility scholarships, and encourage awareness and trust in science in both Dutch and Indonesian society. KNAW also promotes international science and research by participating in international networks of scientific academies at European and international level.

International collaboration is one of the priority themes of NWO, which promotes international linkages in science and research in Europe, in the framework of EU programmes, and beyond. NWO international co-operation programmes include: Rubicon, a programme offering doctoral holders post-doc experience in a top research institution outside the Netherlands; the China-Netherlands Joint Thematic Research Programme (JSTP), which promotes joint thematic research collaboration by Sino-Dutch research teams and Sino-Dutch networking seminars; the Hé Programme of Innovation Co-operation, which promotes joint research projects of Chinese and Dutch universities and business organisations; the Visitor's Travel Grant, which covers the cost of visiting foreign researchers who contribute to Dutch research projects for six months; and the New Netherlands Polar Programme, which promotes high-quality scientific research in the polar region. NWO also promotes the use of Dutch international research facilities by researchers abroad and the use of international large-scale research facilities located in foreign countries by Dutch researchers.

NUFFIC (Box 5.21) defines and manages programmes that support the international mobility of students. The Orange Tulip Scholarships offer talented students from Brazil, China, Indonesia, Korea and Mexico the opportunity to complete higher education in the Netherlands. Other programmes target the Middle East and North Africa (MENA) region. The Huygens Scholarship Programme, launched in 2006, promotes international mobility of foreign students to the Netherlands and of Dutch students abroad.

Many Dutch universities are active in international recruiting and all academic vacancies are advertised on the international portal Academic Transfer. However, current foreign workers' visa regulations create obstacles for the recruitment of non-EU citizens. In 2013, the government launched a pilot measure to address this issue. For a period of two years, employers in knowledge- and innovation-intensive sectors are not required to apply for a visa to recruit non-EU citizens. However, this pilot project only applies to large R&D companies with an annual turnover above EUR 50 million or orders above EUR 5 million (Ministry of Economic Affairs, 2013a).

Box 5.21. NUFFIC, the Netherlands organisation for international co-operation in higher education

NUFFIC is an independent non-profit organisation established in 1952 to support knowledge sharing and internationalisation in higher education, research and education, promote co-operation with foreign countries and improve access to higher education globally. NUFFIC operates mainly together with the Dutch Ministry of Education, Culture and Science and the Dutch Ministry of Foreign Affairs. Approximately 250 people are employed by NUFFIC, 200 in the head office in The Hague and 50 in support offices located in areas of strategic importance for higher education: Brazil, China, India, Indonesia, Mexico, Russian Federation, Korea, Thailand and Viet Nam.

NUFFIC's main operational activities include: managing international education programmes on the instructions of the Dutch government, the EU or other institutions; providing detailed information and statistics on international higher education activities of Dutch organisations; disseminating information on higher education systems and foreign legislation; strengthening the international position and raising the international profile of Dutch higher education and scientific research. NUFFIC manages a number of scholarship programmes on behalf of a number of organisations.

NUFFIC co-operates extensively with other major Dutch STI actors: the Advisory Council for Science and Technology Policy (AWT), the Social and Economic Council in the Netherlands (SER), the Confederation of Dutch Industry and Employers (VNO-NCW), the Ministry of Economic Affairs, the Netherlands Development Organisation (SNV) as well as other research institutes and think tanks.

Source: www.nuffic.nl.

A number of international education institutions are located on Dutch territory: the UNESCO IHE Institute for Water Education; the United Nations University – Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT); the Institute for Housing and Urban Development Studies (IHS); the International Institute of Social Studies in The Hague. The Netherlands is a joint funder and member of international research organisations such as the European Council for Nuclear Research (CERN), the European Molecular Biology Laboratory (EMBL), the European Molecular Biology Conference (EMBC), the International Thermonuclear Experimental Reactor (ITER), the European Organisation for Astronomy Research (ESO) and the European Space Agency (ESA).

Along with strengthening internationalisation in higher education and research, promoting international trade and investment connections of business organisations is a key priority of the government and the top sectors approach. The top sectors agenda aims to strengthen and support the international and global economic connections of Dutch firms in the top sectors in various ways. In particular, the government wishes: to strengthen Dutch economic diplomacy in foreign countries;[37] to brand and promote more effectively the Netherlands abroad; to develop a plan for strategic acquisition of foreign companies in the top sectors; and to attract foreign investments and stimulate development co-operation.

The government also plans to establish a network of top-sector representatives abroad to facilitate these tasks, with a focus on the BRICs. The government has strengthened the participation of entrepreneurs in official ministerial missions abroad, as an opportunity to meet other entrepreneurs and policy actors in foreign countries, establish contacts, engage in networking and benefit from branding opportunities. The participation of former CEOs and high-level executives can help to identify export and foreign investments opportunities. Each top sector selects priority countries and develops marketing strategies for those countries in co-operation with the relevant foreign embassies. On the basis of the preferences expressed by each top team, a strategic travel agenda is designed at the government level. Special attention is paid to the representation of SMEs in high-level events and to the promotion of SMEs' international networks. European countries remain a priority for the exports and international activities of SMEs and smaller enterprises. Additional actions are taken in the framework of development co-operation programmes.

To attract foreign investments, the government aims to focus on high-quality strategic investments in the top sectors in co-operation with the Netherlands Foreign Investment Agency and the technical-scientific attachés. The focus on emerging markets will be expanded and foreign embassies, consulates and business support offices will help attract investors in key countries. A Steering Group for Acquisition and Business Climate, led by the Ministry of Economic Affairs (with representatives from regional and local authorities and representatives of the top sectors) was created to supervise and steer the Dutch acquisition strategy. Advisory teams of foreign CEOs will advise foreign companies interested in establishing businesses in the Netherlands and provide the relevant documentation for foreign companies and expatriates. The government also aims to reduce or eliminate unnecessary regulatory barriers to exports within EU borders and beyond. The Partners for International Business, a public-private partnership programme, was established in 2012 to position companies or groups of companies (especially in the top sectors) in promising foreign markets. The programme is managed by the newly created Netherlands Enterprise Agency. The Ministry of Economic Affairs and the Ministry of Foreign Affairs will work to co-ordinate development co-operation efforts and to promote knowledge sharing between Dutch firms and knowledge organisations and developing countries.

From the account above, it is apparent that several ministries and agencies are active in supporting international knowledge linkages in their different aspects. According to KNAW, it would be valuable for the Netherlands to develop a national internationalisation strategy in order to prevent duplication and promote co-ordination. The promotion of international co-operation among students, researchers and institutions may in fact require international agreements and legal frameworks that are typically administered and developed at the central government level. The government's active support, for instance, is essential to remove unnecessary legislative obstacles and regulations that hinder internationalisation. The German Internationalisation Strategy of the late 2000s is an example of a co-ordinated effort to develop a national internationalisation strategy for science and innovation (OECD, 2013f).

Maximising benefits from the participation in European programmes for science and innovation

The participation of Dutch research and innovation organisations in the European Framework Programmes (FP) has been very successful by average European standards (Box 5.22).

Box 5.22. Dutch participation in FP7

According to the latest FP7 monitoring report (EC, 2013b), covering the period 2007-12, the Netherlands' application success rate is significantly above the EU average (23% vs. 17%), second only to Belgium. In terms of funding attracted, the Netherlands ranks fifth, behind Germany, the United Kingdom, France and Italy, all significantly larger countries. Dutch universities perform well: among the top 50 participating universities, they are fewer in number than UK and German universities but more than Swedish ones. However, no Dutch university is listed in the top ten participating universities (which are mostly UK and Swiss). For participation by research organisations and the private sector, the leading Dutch institutions are TNO (ranked 10th) and Philips (8th). The participation of Dutch SMEs, instead, is only slightly above EU averages (EC, 2013b). Overall, SMEs account for 14.3% of the total FP7 budget (2007-June 2013). Dutch SMEs account for 15.8% of the EU budget received by Dutch organisations, less than in Austria and Belgium (21.9%), Denmark (17.3%), France (17.2%) or Germany (16.1%). The country has also been successful in terms of grants awarded by the European Research Council: since 2007, the number of Dutch funded projects is 193 for younger researchers,[38] fewer than the United Kingdom (495), Germany (326) and France (314) but more than Switzerland (145). Senior researcher grants[39] numbered 137, fewer than the United Kingdom (402), Germany (242), France (211) and Switzerland (153). The Netherlands performs above average in the Eurostars programme, an EU instrument targeting SMEs.

Source: EC (2013a), EC (2013b).

Box 5.23. Horizon2020, the European Framework Programme for Research and Innovation 2014-20

Horizon2020 is the EU programme for science, research and innovation for the programming period 2014-20. The budget over the seven years is about EUR 80 billion. Horizon2020 is structured around three thematic pillars: **excellent science**, **industrial leadership** and **societal challenges** and has a number of programmes and agencies targeting specific actions or scientific domains.

i) Excellent science. The initiatives under this pillar aim to strengthen and extend EU scientific activities and consolidate the European Research Area. This pillar has four main objectives and programmes: the European Research Council, future and emerging technologies, the Marie Sklodowska-Curie Actions for training in science and research, and research infrastructure.

- The *European Research Council* supports frontier research and interdisciplinary activities in new and emerging disciplines through competitive funding on the basis of scientific excellence. The total budget for ERC programmes under Horizon2020 is EUR 13 095 million.

- *Future and Emerging Technologies* (FET) initiatives are expected to achieve breakthrough science and innovation through cross-disciplinary research collaboration. Under Horizon2020, FET initiatives are allocated a budget of approximately EUR 2 696 million. The FET programme is organised along three main lines of action: FET Open, to support early-stage S&T research arising from unconventional collaborations in multiple fields of science and innovation; FET Proactive, to support emerging themes and structure communities around promising exploratory research themes; FET Flagships, to support large-scale and long-term research activities to meet grand challenges. FET Flagships requires a long-term commitment from key stakeholders. FET Flagships chosen under Horizon2020 are the Graphene and Human Brain projects. …/…

Box 5.23. Horizon2020, the European Framework Programme for Research and Innovation 2014-20 *(continued)*

- The *Marie Sklodowska-Curie Actions (MSCA)* will have a budget of EUR 6 126 million. It will support career development and training of researchers and scientists in all disciplines through cross-border and cross-sector mobility. The programme targets researchers at all stages of their careers. In addition, MSCA will be the main EU programme for doctoral training and promote the involvement of the business sector in doctoral and post-doctoral research.

- The *European Strategy Forum on Research Infrastructure (ESFRI) roadmap* seeks to develop, open and integrate national research facilities and e-infrastructure in the European Research Area. Its main goals are to avoid duplication and to co-ordinate efforts of member states. The roadmap encourages exchanges of researchers and scientists in different facilities and closer industry-academia co-operation.

ii) **Industrial leadership.** The Industrial Leadership pillar is organised around three main objectives and programmes: *Leadership in enabling and industrial technologies,* to support R&D in ICT, nanotechnology, advanced materials, biotechnology, advanced manufacturing and processing, and space, by emphasising possible interactions and convergences across and between different technologies and fields and societal challenges; *Access to risk finance,* to support the development of venture capital at EU level (together with the Competitiveness of Enterprises and SMEs) at all stages of companies' development; *Innovation in SMEs*, to provide support to promote innovation, growth and internationalisation of SMEs.

iii) **Societal challenges.** Under this pillar, resources from different fields are brought together to focus on grand challenges for EU societies. Funding instruments will focus on: health, demographics and wellbeing; food security, sustainable agriculture, water research and the bio-economy; clean and efficient energy; smart, green and integrated transport; climate action, environment, resource efficiency and raw materials; inclusiveness; secure societies.

iv) Other key institutes and programmes include *the European Institute of Innovation and Technology (EIT)* and the *Joint Technology Initiatives (JTIs).* The goal of EIT is to reinforce the innovation capacity of the EU and its member states in order to address the grand challenges facing European society. Over 2014-20 EIT will receive EUR 2 711 million to promote innovation in Europe. EIT was created to integrate education and entrepreneurship with research and innovation at the EU level. It works via the knowledge and innovation communities (KICs) to develop and test new models for approaching, managing, financing and delivering innovation. In 2010 three KICs were established to address innovation in climate change, sustainable energy, and ICT. From 2014 new KICs will be established in the following fields: innovation for healthy living and active ageing; raw materials (in 2014); added-value manufacturing and food4future (in 2016); urban mobility (in 2018).

v) JTIs are the EU instruments for public-private partnerships and were introduced in FP7. JTIs allow the EU and the business sector to fund and implement jointly some FP7 initiatives. Five JTIs were implemented under FP7: aeronautics, pharmaceutical research, fuel cells and hydrogen, embedded systems, and nano-electronics. Under Horizon2020, JTIs will focus on strong or emerging sectors of the EU knowledge-based economy. The priority areas for JTIs are: innovative medicines; fuel cells and hydrogen; clean sky; bio-based industries; electronic components and systems. These five JTIs are estimated to mobilise total investments of over EUR 17 billion (EUR 6.4 billion in EU funding).

Source: http://ec.europa.eu/programmes/horizon2020/.

The 2014-20 European Framework Programme for Research and Innovation, Horizon2020 (Box 5.23), will combine different sources of European research and innovation funding under a single programme.[40] Its priorities are scientific excellence, industrial leadership and societal grand challenges (climate change, sustainable transport and mobility, affordability of renewable energies, food safety and security, ageing population). Access to credit and promoting innovation in SMEs will be two of the main priorities of the industrial leadership pillar. Horizon2020 aims to simplify the administrative procedures of previous FPs, in particular to strengthen the participation of SMEs, which often lack the resources to undertake time-consuming administrative procedures.

The Ministry of Economic Affairs and Ministry of Education, Culture and Science (2014) have recently acknowledged the opportunities arising from the Horizon2020 agenda for Dutch science and innovation actors. In particular, there are promising avenues for strengthening the links between the European STI agenda and the top sectors approach. Many of the EU grand challenges are directly related to some of the top sectors (energy, water and climate change; agri&food and food safety and security). The importance of these links was recently noted by the Dutch Council for Science and Technology Policy, which recommended closer connections between the top sectors approach and grand societal challenges. According to the Council, these links have been insufficiently developed or exploited and can be reinforced through a cross-theme approach (AWT, 2013). Further alignment of the top sectors agenda and Horizon2020 represents an opportunity not only to facilitate top-sector participation in EU programmes, but also to encourage further cross-sectoral exchanges, with great innovation potential. In addition, the shift towards less administrative burden and easier access to credit, especially for SMEs, is a main concern not only at the European level but also for the top sectors. National innovation policies may therefore benefit from co-ordinating efforts with the European agenda, especially on topics of importance for the Dutch innovation system. Moreover, given the attention that top sectors devote to internationalisation, synergies between the top sectors and the European agenda are important to strengthen international collaboration by firms and research institutions in the top sectors and beyond.

In order to better capture the possibilities for co-operation with EU programmes, the Ministry of Economic Affairs recently developed measures to encourage the participation of Dutch organisations in European programmes: an annual budget of EUR 100 million has been allocated to European programme from 2015 onwards, of which EUR 13 million is earmarked (over the full Horizon2020 period, 2014-20) to strengthen the participation of Dutch SMEs. Initiatives to better inform and advise SMEs about possibilities for participating in European programmes and finding international partners for co-operation have been established. In addition, EUR 36 million has been allocated for 2014-17 to co-fund participation in European research projects focused explicitly on grand challenges.

Notes

1. Technologies of this kind include ICT, biotechnology or nanotechnology. They are distinguished by their wide scope of applicability throughout the economy and across industrial sectors. Practically all OECD countries, in one way or another, have supported the development or adoption of these technologies. To focus on enabling technologies with an impact throughout the economy is another attempt to foster technological progress while avoiding the pitfalls of the old, more narrowly oriented, sectoral industrial policy approaches.
2. Subsequently the agency expanded and its name was changed to Senter, SenterNovem and AgentschapNL in the wake of several mergers.
3. This section draws extensively on de Heide et al. (2013).
4. The extent to which the concept of "focus and mass" was actually applied has been questioned: "in many ways, the government did not apply this strategy of focus and mass to its research and innovation policy. E.g. a large part of the policy was based on ad-hoc budgetary decisions to increase the FES funds, and there is no focus or strategy in the large and very diverse mix of investment projects. Another example of the lack of focus and strategic policy-making is the observation made by the AWT that three of the largest institutions in the Dutch research structure, namely TNO, NWO, and KNAW, all have their own, different research themes" (Wintjes, 2007).
5. Quoted from de Heide et al. (2013).
6. The FES complemented the research budgets of the relevant ministries. Wintjes (2007) argues that co-ordination and control was difficult and the objectives too broad and diverse to be called priorities. Moreover, the funding was *ad hoc* and covered a very diverse set of activities and projects for which funding through normal procedures was not available. Arguably, the procedures to assess the financed projects improved over time and compared rather well to those of other measures.
7. In the 1990s, there was a shift away from support for individual companies, and increased focus on generic R&D support.
8. The other tax-based instrument, the innovation box, is implemented by the Netherlands Tax Office.
9. The polder model (sometimes referred to more generally as the "consultative economy") involves wide-ranging consultation for decision making in a tripartite co-ordination process involving employers, employees and government. According to some, it dates back to the time when broad cross-sections of the diverse Dutch population had to co-operate to reach agreement on maintaining the costly system of water defences (SER, 2013).
10. There is, however, a Standard Evaluation Protocol which has been recently updated (VSNU, KNAW, NWO, 2014)
11. It should be noted that there is disagreement about the coverage of Top Sectors. According to not much older Statistics Netherlands publication (Statistics

Netherlands, 2012) the Top Sectors account for a much higher 96% of total BERD. The share of export value includes re-exports and would be much higher if they were excluded.

12. One example cited in the original top sectors proposal (Ministry of Economic Affairs, 2011) is Wageningen University and Research Centre's testing sites, where university scientists and researchers from applied research institutes are brought together to exchange knowledge. Firms can learn about research results at these testing sites and can contribute to their funding through their product boards.

13. The top sectors approach also envisages reducing the administrative burden for businesses, uniting the disparate channels of public support to businesses with a one-stop shop for service delivery (*Ondernemersplein*).

14. On 3 March 2014 the Cabinet announced additional funding from 2015: EUR 50 million EU co-financing (for EU public-private programmes and public to public programmes) and EUR 50 million matching (a top up for public R&D institutes to cover indirect costs at EU project level). www.rijksoverheid.nl/documenten-en-publicaties/kamerstukken/2014/03/03/kamerbrief-met-uitwerking-begrotingsafspraken-2014.html

15. According to some, the economic rationale for the Top Sectors is (similar to other forms of innovation-minded government intervention) based on the presence of strong positive externalities due to knowledge spillovers and of benefits from co-ordination (sometimes referred to, under a different framework, as 'systems failures'). In both of these cases the same question applies: It is unclear that sectors of existing strength have (as much) room for further growth in either R&D intensity or exports as, e.g. sectors at an intermediate stage of their development.

16. Progress in aligning the Top Sectors with global societal challenges is documented in Ministry of Economic Affairs and Ministry of Education Culture and Science (2014).

17. The SBIR budget of central government was reduced after 2010, to EUR 6.2 million in 2013. Partly reflecting the evaluation in 2010, it was decided that regional and local governments as well as dedicated agencies (such as Rijkswaterstaat) should contribute more. The magnitude of this instrument can thus not be judged on its central government budget. No data on the uptake of this instrument throughout the country was available at the time of the review.

18. It should be emphasised however that this is conditional on resolving some of the coordination problems identified by Hessels and Deuten (2013). Lack of trust and conflicts of interest may prevent companies from sharing their future plans or signals of opportunities. This is one of the mechanisms that can make stakeholder-led programming inductive to short-termism.

19. The Finnish SHOKs are, like the top sectors, large-scale PPPs built around strong industrial sectors. The 2013 evaluation of this scheme indicated that, in contrast to the original objectives, some of the SHOKs had focused on fairly short-term and unambitious research projects (Lahteenmaki-Smith et al., 2013).

20. Lagging innovation performance may of course be also a symptom of deeper issues in parts of the business sector that go beyond the scope of this review. For example, according to some studies (e.g. Kox, 2012) the lagging productivity of certain types of sectors is due to competition and regulatory issues. As regulatory issues are resolved and markets become more competitive innovation would become more important for these firms.

21. The performance agreements also include commitments on research profiling and valorisation, which are discussed further below.

22. In Denmark, the development contracts of universities were first introduced by the revision of the *University Act* in 1999 as part of a reform of university governance that provided universities with greater scope and flexibility to meet their challenges (Benneworth et al, 2011). In Austria, performance agreements were adopted for university general funds in 2004 based on the *Universities Act 2002*. In Finland, performance agreements with individual universities have gradually been adopted since 1994 (Ministry of Education and Culture, Finland).

23. Sweden and Finland have made a direct link between the outcomes of quality evaluations and funding, but only for stimulating excellence. The Ministry of Education, Culture and Science claims the Dutch system to be innovative because it uses a nuanced indicator set in combination with funding and agreements with the individual institutions.

24. However, a university's strategic development does not only depend on the formal governance system. It can be influenced as much or more by the initiative of key persons with vision and determination. For example, reforms at the University of Twente started long before the introduction of the 1997 reform and were implemented on the initiative of the then rector and administrative director. Together they set out to transform the university from a marginal position into an innovative and entrepreneurial university by changing the budgetary system (lump-sum, cost-centre, responsibility-centre budgeting) (Clark, 1998, p. 45).

25. Specifically, AWT suggests that the committee should also ensure strategic coherence with EU strategies, pay attention to the present and future costs of existing research facilities, focus on the quality of research facilities, explore the possibility of public-private partnerships for the development and the use of the infrastructure. The committee should also be aware of the degree of alignment between research infrastructure and specialisation and development strategies of universities, research institutes and regions.

26. The term "valorisation" is commonly used in the Netherlands but rarely used elsewhere. According to the Dutch National Valorisation Commission (cited in Rathenau Institute and STW, 2011), valorisation refers to "the process of creating value from knowledge by making knowledge suitable and/or available for economic and/or societal use and translating that knowledge into competitive products, services, processes and entrepreneurial activity".

27. Following this recommendation, the General Board of NWO decided that from 2014, valorisation should be part of the assessment of applications in all of NWO's funding instruments, including the talent and curiosity-driven research programmes. NWO explicitly asks researchers to state how their research might be of interest to other scientific disciplines, society or industry. The assessment procedure for the talent and curiosity-driven research programmes has been set up so as not to disadvantage researchers who can clearly present the reasons for the lack of any prospect of knowledge utilisation in the foreseeable future. Valorisation will be assessed during the monitoring and evaluation of funded projects and programmes.

28. To recall, the contribution of public research is evident not only in strong performance in the various available indicators of commercialisation, but especially in supporting the production of very high quality human resources, raising the

visibility of the Netherlands as a knowledge-intensive economy and attracting international talent.

29. In this respect, success rates in some of NWO's first top-sector-related calls could be a cause for concern: for example, in the STW HTSM call 2012, out of 73 project proposals, 32 were funded (44% success rate); even higher levels are reported for other top-sector-related calls. These levels are somewhat higher than the average success rate of 35% for NWO thematic programmes (Table 5.10) and reflect relatively low submission rates for some of the top-sector-related calls. This may be due to a number of factors: the relevant industry-academic networks may not yet be well established in many areas; in-kind or in-cash contributions from private partners may be difficult to secure; and in some research areas there is little experience (on both sides) with such kinds of collaboration. These factors could change over time as relationships in the top sectors develop further. In the meantime, there is a risk that under-subscribed calls could compromise research quality.

30. KNAW (2013) makes a related, though broader point: "not all research that is vital to society can be described in terms of economic utility. In a society that functions effectively, including a properly functioning knowledge economy, security, social trust, good governance and similar matters are vitally important . . . It is at least as important for research to derive its value and meaning from more than its direct relevance to society. A high-value knowledge society requires high-value, broadly educated people who are capable of acting independently and creatively when tackling new challenges. Any random academic programme might contribute to meeting that general aim."

31. In this regard, it is essential to recall the rationales for direct government funding of the TO2 institutes (see Box 4.6), which include the need to offset market failures.

32. Evaluation results are expected to be just one input that will be combined with a balanced vision of the interests and research needs in the fields of economic competitiveness, societal themes, and policy and statutory tasks in determining the allocation of funding for subsequent periods.

33. Territorial Level (TL) 2 regions represent the first administrative tier of subnational government, such as regions in many European countries or States in the United States; Territorial Level (TL) 3 regions are smaller administrative areas contained in TL2 regions. They refer for example to provinces in many European countries.

34. Some peaks in the delta projects were continued until 2011.

35. These findings are confirmed by studies on the Netherlands (Frenken et al., 2007), Italy (Boschma and Iammarino, 2009) and Spain (Boschma et al., 2012). In addition, studies in economic geography suggest that the type of agglomeration externalities varies according to the level of maturity of industries: Jacobs externalities (knowledge spillovers emerging from the agglomeration of firms in different industries) are more beneficial to new industries, whereas Marshall-Arrow-Romer (MAR) externalities (knowledge spillovers emerging from spatial agglomeration of firms in the same industry) are more beneficial to mature industries (Potter and Watts, 2011; Henderson et al., 1995; Neffke at al., 2011; Boschma and Frenken, 2011).

36. For a list of regional initiatives see: www.antwoordvoorbedrijven.nl/subsidies/innovatie/provincie.

37. Letter to the Dutch House of Representatives: "Modernising Dutch Diplomacy", available at:

http://www.minbuza.nl/en/appendices/the-ministry/about-the-ministry/missions-abroad/reforming-diplomacy-clear-choices-new-emphases/letter-to-the-house-of-representatives-modernising-dutch-diplomacy.html.

38. Starting grants for researchers with 2-7 years of experience, grant budget of EUR 1.2-2 million.

39. Advanced grants for leading researchers, grant budget between EUR 2.5-3.5 million.

40. The sources are the Framework Programmes for Research and Technical Development, the Competitiveness and Innovation Framework Programme (CIP) activities related to innovation and the European Institute of Innovation and Technology.

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Annex 5.A1

The evolution of Dutch innovation policy since 2002: An overview

This annex is derived from the background report for this review provided by TNO (de Heide et al., 2013).

Five governments took office in the period from 2002 to present, each with their own view on how the innovation system should be fostered. In the following, the evolution of Dutch STI with links to Higher Education policy is outlined based on the coalition agreements between the political parties participating in the respective governments.

Balkenende I[1] (2002)

The Strategic Agreement (*Strategisch Akkoord*) of the first Cabinet Balkenende identifies increasing labour productivity as a primary objective in response to a decreasing labour supply owing to demographic change. Proposed interventions refer to improving the entrepreneurial climate and further wage moderation. R&D and innovation are not mentioned in the Agreement.

Balkenende II[2] (2003)

R&D and innovation play a prominent role in the Outline Agreement (*Hoofdlijnenakkoord*) of the Balkenende II Cabinet. The objective is to position the Dutch innovation system "… in the frontline in the fields of education, research and innovation". This ambition is later defined as achieving a "top-5 position" in these specific policy areas. Specific measures include:

- Set-up of an Innovation Platform (i.e. Innovatieplatform I, following the successful example of the Finnish Research and Innovation Council) with stakeholders from the Dutch innovation system ("Triple Helix" approach).
- Increasing of the budget for fiscal measures for industry-oriented R&D (WBSO).
- Changing in the structure of funding of R&D performed by the public research infrastructure (i.e. Research Institutes and Higher Education) from direct / base funding (first flow of funds) to project funding (second flow of funds via NWO) in order to increase competition and improve quality (applicability) of output.
- Promoting / encouraging enrolment and completion of studies in S&T disciplines at Higher Education Institutions.

1 Cabinets are named after the Prime Minister in the Netherlands. Balkenende I took office on 03/06/2002, and was constituted by CDA (Christian-democrats), LPF (populists), VVD (liberals).

2 Constituted by CDA (Christian-democrats), VVD (liberals), and D66 (left-liberals) on 16/05/2003.

Balkendende IV[3] (2007)

The Coalition Agreement (*Coalitieakkoord*) of Balkenende IV, too, identifies R&D and innovation as an important element for strengthening the competitiveness of the Dutch economy. Important decisions concerning policy and instruments are:

- Continuation of the Innovation Platform (i.e. *Innovatieplatform II*). [Note: It was discontinued in 2010].
- Intensification of thematic scope in research and innovation policy (initiated also by the AWT advisory letter "Backing Winners", and consultation / advice from the first Innovation Platform) by continuation / further implementation of the "Key Areas Approach" (Sleutelgebiedenaanpak).
- Strengthening / further intensifying the WBSO and innovation vouchers (especially for SMEs).
- Additional investments in the Higher Education sector (first as well as second stream funding), especially project funding for basic scientific research on renewable energy;
- Additional resources to strengthen the role of the government as "launching customer" for new innovative technologies.

Rutte I[4] (2010)

The Cabinet Rutte I in its Government Agreement acknowledges the necessity of strengthening the competitiveness of the business enterprise sector by a "… specific and targeted policy for the advancement of innovation". In contrast to previous Cabinets, Rutte I links this policy focus to "policy aimed at supporting and strengthening entrepreneurship". The Cabinet also adopts the ambition that the Dutch innovation system should belong to the "top-5 of knowledge economies in the world". The "3% objective" however is abandoned; the new target is the allocation of 2.5% of GDP to GERD. Major initiatives include the following:

- Further shift towards a thematic policy approach: from "Key Areas" (focusing on (industrial) R&D and innovation) to "Top Sectors" (focusing on (industrial) R&D and innovation, and entrepreneurship).
- Further embedding (industrial) R&D and innovation policy into industrial policy, as part of a dedicated economic growth strategy. This is also reflected in the establishment of a new Ministry of Economic Affairs, Agriculture and Innovation that coordinates / governs all innovation-related measures.
- Redesigning of the mix of support instruments for R&D and innovation, with a reduction of the financial contribution through direct support measures and an increase in fiscal support.

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3 Constituted by CDA (Christian-democrats), PvdA (Socialists), Christen Unie (Christian-right) on 07/02/2007. After the fall of Balkenende II, the existing Coalition minus D66 briefly continued as Balkenende III in order to bridge the gap towards the next elections. Existing policy (concerning R&D and innovation) was continued by this interim Coalition.

4 Constituted by VVD (Liberals), and CDA (Christian-democrats) on 07/10/2010.

- Creation of "Focus and Mass" in subsidies by simplification and combination of existing tools (allowing only for subsidies with proven effectiveness).
- Set-up of a revolving fund of subsidies addressing the innovation process.
- Intensified corporate tax reduction and extension/increase of WBSO.
- Emphasis on support of exploitation/valorisation of knowledge, especially by SMEs.
- The central government abandons regional economic policy (e.g. regional R&D and innovation policy). A (more) prominent role in advancing regional economic development is foreseen for Regional Development Agencies.
- The Government Agreement does not contain a financial overview addressing the main interventions as described above. During the period of office of the Cabinet however, it was decided that budget constraints were required to address the upcoming financial and economic crisis. A prominent decision involved the termination in time of support from the FES, which ultimately will result in a cut of EUR 400 million of R&D funding.

Rutte II[5] (2012)

The current Cabinet Rutte II has adopted the basic stance of the previous Cabinet concerning support of the Dutch innovation system in order to strengthen competitiveness, and provide a basis for innovation-driven economic growth.

5 Constituted by VVD (Liberals), and PvdA (Socialists) on 29 October 2012.

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